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ASSOCIATION

A SYSTEM OF

# GENITO-URINARY DISEASES

## SYPHILOLOGY AND DERMATOLOGY.

*BY VARIOUS AUTHORS.*

EDITED BY

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GENITO-URINARY DISEASES

WITH NUMEROUS ILLUSTRATIONS.

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# RUPTURE OF THE BLADDER.

By ALEXANDER W. STEIN, M. D.

**Definition.**—Rupture of the bladder may be divided into three classes: intraperitoneal, extraperitoneal, and subperitoneal—that is, the lesion may be situated within the limits of the peritoneal covering, and involve that structure; it may be located at some point of the viscus not invested by the peritonæum; or it may be that the lesion occurs within the limits of the serous tunic, but the rupture is incomplete, the mucous and muscular coats alone giving way, allowing an extravasation of urine beneath the peritoneal covering, which latter remains intact. A few cases are on record in which the lesion was both intra- and extraperitoneal. Intraperitoneal ruptures are more frequent than extraperitoneal, nearly as three to one. This finds an explanation in that when the bladder is fully distended, and is subjected to violent or sudden compression, the peritonæum, which is then the most tense and least yielding of the several tunics, will split in advance of the subjacent coats, and carry the latter with it in the laceration; whereas, in situations where the peritonæum is absent, the coats of the bladder are more elastic and yielding. Subperitoneal ruptures are certainly not common, there being but thirteen on record, yet it is probable that they have occurred somewhat oftener than we find recorded. In several cases of recovery there is every reason to believe that the extravasation was partial or subperitoneal; while the long duration and slow progress of some cases of intraperitoneal ruptures can be accounted for only in the supposition that at first the extravasation was subperitoneal, and that the peritonæum became subsequently involved by pressure or a necrotic process. Such a conclusion would seem inevitable when, following a fall or an injury, symptoms of vesical rupture appear, and continue for several days without being very grave, until suddenly after a straining effort, something is felt to snap or crack in the abdomen, after which rapid and fatal peritonitis ensues. This is the history given in several instances.

**Location.**—As regards the exact location of the lesion, our histories are definite in only a limited number of cases. In the intraperitoneal variety, we find the superior region of the bladder mentioned in 79 cases. In 59, the laceration is said to have been at the posterior wall; 36 times at the upper part, and 19 times at the lower part. The extraperitoneal lacerations occurred anteriorly in 25, in 7 at the side, and in 6 at the lower posterior portion of the viscus. We thus find that the largest number of intraperitoneal ruptures occur at the upper and posterior part of the bladder, where the viscus is thinnest, and where, in the course of distention, it comes in relationship with the sacral promontory. In these cases there need be no bony lesion; the relationship of the bladder to the bony prominence behind is such that any external violence or pressure may cause the injury, and the reason for the more frequent location of intraperitoneal ruptures in the upper and posterior portions of the bladder is found in the force being directed upon the upper part of the viscus, which is thus compressed against the vertebro-sacral eminence. Extraperitoneal lacerations are ordinarily found in front. The cause of this is manifest in the fact that the anterior surface of the bladder, being in immediate contact with the pelvic zone, is most exposed to injury from lesions of bone. The majority of ruptures situated anteriorly are complicated with fracture of the pelvic bones.

**Character of Lesion.**—The rent may be perpendicular, transverse, or oblique. It is usually linear. It seldom presents as a gaping wound or hole. When such exists, it varies in size from a minute opening to one admitting the passage of several fingers. The rent is generally ragged and its edges everted. Its length varies from 1 to 12 cm. Extraperitoneal lacerations have, so far as we know, not exceeded 5 cm. in length; nor is the rent larger in the greatest number of intraperitoneal ruptures, but in several of these the tear was said to be from 5 to 12 cm. in length. The coats may not be torn equally. In intraperitoneal rupture especially, the serous investment is apt to tear more than the other coats. In one such case the rupture in the bladder is said to have been 3 cm., while that in the peritoneal covering was 15 cm. in length. This is no doubt owing to the fact, already mentioned, that the peritonæum is the least yielding of the vesical coats, and, being upon the stretch, splits first and most. As a rule there is but one rent; exceptionally, two or three points have given way simultaneously. In two or three cases the edges of the rent were found to be so overlapped as to form a kind of valvular closure, or a loop of intestine was adherent by recent adhesions, which prevented the further escape of urine from the bladder. Morris (Med.-Chir. Trans., vol. lxx) mentions a unique case of this kind, in which the bladder was twice ruptured, the first time by violence, the second time, seven years after, by giving way of the adhesions between the bladder and rectum.

**Etiology.**—The causes may be divided into predisposing and determining, or traumatic and non-traumatic. The first and most prominent predisposing cause is distention of the bladder, the danger of rupture being proportionate to the degree of fixation and elevation of the viscus above the true pelvis, and in front of the projecting lumbo-sacral angle. While it would appear that distention is not a *conditio sine qua non* to rupture, a more or less replete state of the bladder no doubt exists in nearly all cases previous to the accident. In the majority of cases the injury occurs while under the influence of alcohol. The etiological influence of alcoholism is manifest—in the diuretic action of the drug rapidly increasing the accumulation of urine in the bladder, and in the obtunding of sensibility, vesical as well as general, whereby this undue accumulation is disregarded. Other predisposing causes of rupture are atony, fatty degeneration, sacculation, and ulceration of the vesical walls. In the majority of cases the autopsy showed that the coats of the bladder were healthy at the time of the accident, but the conditions of the bladder just mentioned render it very liable to rupture, even under circumstances of moderate distention, and from comparatively trivial causes.

It is probable that in rupture primarily depending upon some long-existing mechanical obstacle to the escape of urine, such as urethral stricture or prostatic hypertrophy, some physical or pathological changes have existed in some instances prior to the rupture of the viscus, but in many cases no such changes were found. One would suppose that a degree of thickness or hypertrophy of the vesical walls would be a safeguard against rupture, but this condition of the bladder is specially noted in several cases. A specimen in my possession shows an extensive laceration through a contracted bladder, whose walls in some places are three fourths of an inch thick. This man had long suffered with stricture of the urethra, and had received a kick in the abdomen causing the laceration. The most common determining cause is some external violence applied over the region of the viscus, a sudden kick or blow over the hypogastrium, a simple tumble, or a fall from some point of elevation, the falling or kneeling of one individual upon the abdomen of another; these are most frequent causes, and are generally incident to drunken brawls. In another class of cases the injury is occasioned by the falling of a beam, the caving in of a wall or of an embankment, the passage of a wagon over the abdomen, etc.; these are frequently complicated with fracture of the pelvic bones, and it is difficult often to determine during life whether the injury to the bladder is the direct consequence of the compression, or due to the laceration of its coats by spicula of bone penetrating its cavity.

In the empty state the bladder is so deeply situated in the pelvic cavity that it is in a great measure protected from external violence, and, as a rule, can only be injured by such force as will separate the pubic symphysis or fracture the pelvic bones. But rupture by *contre-coup*, as in falling from an elevation upon the feet or buttocks, has occurred even when the bladder was comparatively empty.

The cause of rupture may emanate from the individual himself, as occasioned by violent straining in micturition, defecation, and in lifting heavy weights. Rupture of the bladder depending upon stricture of the urethra as a primary cause is not common, for the reason that in stricture of the urethra the canal behind the obstruction, having become dilated and attenuated by the constant pressure made upon it during urination, will yield in preference to the bladder, which organ, under these circumstances, is often rather hypertrophied than atonied. Nevertheless, not a few instances of vesical rupture from straining to overcome an obstructed urethra have occurred.

Those instances in which the accident was primarily dependent upon prostatic enlargement were all intraperitoneal. The bladder has been ruptured during parturition—a fact to be remembered in always keeping the bladder empty during the progress of labor. Some cases are recorded as having occurred from retention of urine caused by retroverted gravid uterus. A man with retention, laceration of the urethra, and extravasation of urine, sustained in addition a rupture of the bladder in his struggles while undergoing etherization—a warning not to administer anæsthetics while the bladder is in a condition of distention. A number of times the viscus has been ruptured from the overdistending force of the injected fluid preparatory to a suprapubic cystotomy. Assmuth mentions two cases of the intraperitoneal variety which seem to have been caused solely from pressure of the abdominal muscles upon the distended bladder. There was no impediment to the escape of urine, and apparently no diseased condition of the bladder walls. We are told the bladder was ruptured spontaneously, in one instance, "while the man was sitting at the table," in another "while asleep." It occurs more frequently among men than among women, in the proportion of ten to one. This comparative exemption of the female from this injury is due to the fact that women, from the nature of their occupations, associations, and habits of life, are less exposed to the dangers of such an accident; while the greater width of the pelvis, and the interposition of the uterus and its appendages between the bladder and the sacral promontory tends to mitigate and break the force of the concussion or compression exerted upon the viscus.

In children this is a rare accident, notwithstanding their numerous knocks and falls. This may be ascribed to the fact that, owing to the greater sensibility of the bladder in the young, micturition is more frequent, and the viscus is rarely suffered to become greatly distended. The tissues are more yielding and elastic, and the sacro-vertebral angle is less prominent than in later life. In the adult the injury occurs most frequently between the ages of thirty and forty and between twenty and thirty—that is, at that period of life when man, by reason of his occupation, is most exposed to injuries, and when, too, he is inclined to indulge most freely in intoxicating drink.

**Symptoms.**—In consequence of the fracture of pelvic bones, or perhaps simply from shock, the patient is unable to walk, or even to rise from the place where he has fallen; pain severe over hypogastrium; desire to micturate incessant, with an inability to void the smallest quantity of urine, or possibly but a few drops mixed with blood. Constitutional symptoms indicative of great prostration rapidly ensue. Countenance pallid and anxious, pulse feeble and fluttering, perspiration clammy, voice weak and husky, abdomen becomes distended, temperature rises, delirium, coma, or convulsions supervene. If the patient rallies from this shock or collapse, his life may be next imperiled by the development of peritonitis or septicæmia. Infiltration of urine is often remarkably extensive, detaching the pelvic organs from their annexes, descending into the perinæum through the inguinal canal and obturator foramen into the scrotum and thighs, and ascending the abdomen and back, reaching at times as high as the shoulder.

In the majority of cases the symptoms are sufficiently expressive to enable the surgeon to arrive at a prompt diagnosis. Of great diagnostic value is the statement so often made by the patient that, after a blow over the hypogastrium, or while in the act of straining, he "felt something give way within the abdomen," and sometimes adds, "experienced a sudden relief from the discomfort occasioned by the previously distended bladder." The evidence furnished by catheterization is of special value when it is positively known that the individual had not micturated for several hours previous to the accident. Under these circumstances an empty bladder, or one containing but a small quantity of sanguinolent urine, is strongly confirmatory of laceration of the bladder. But the evidence pointing to rupture is by no means always unequivocal. Often the signs and symptoms upon which we would most depend are absent; those that are present are dangerously misleading, and the case is shrouded in uncertainty and doubt. Especially is this the case in the beginning, when a long interval of time may elapse between the receipt of injury and the development of characteristic symptoms. It is important to watch closely a patient on whom the suspicion of rupture of the bladder rests, for, though the symptoms may for a time be latent, once manifest they are rapidly progressive, and everything depends upon a timely and perhaps bold surgical interference. Not only may the first symptoms be delayed or be insufficiently marked to attract attention, but the vesical rupture may be complicated with other injuries whose symptoms may for the time obscure the more dangerous lesion within. As indicating the difficulties sometimes encountered in arriving at a diagnosis, we find that there is rarely any external sign or mark of injury to be found over the abdomen, even where a wagon has passed over the body. We depend much upon the history given as to the nature of the accident, the condition of the bladder at the time of injury, etc.; but if the patient is unconscious or is drunk, as is so often the case, no information can be obtained, or what may be given can not be relied upon. If we will take a lesson from some of the reported cases relative to the constancy and reliability of the most characteristic symptoms, we shall find that standing, or even walking, is not inconsistent with the existence of laceration of the bladder. Neither is the difficulty or inability to micturate a uniform symptom. The patient may have no difficulty in voiding urine, and, indeed, may pass a considerable quantity of water. In some cases it occurred that after the first catheterization the patient regained the power of voluntary micturition.

The absence of difficulty in voiding urine is met with in both extraperitoneal and intraperitoneal ruptures. One patient, with an extraperitoneal rupture an inch long and half an inch wide, communicating with an abscess half full of urine and pus, "passed his urine for three days after the injury as naturally as ever." This man lived thirty-two days; while another patient, with an intraperitoneal rupture one and a half inches long at the summit of the bladder, "was able to pass water without any difficulty." He died eighty hours after the injury.

The marvelous retentive power of the bladder noted in some other cases would seem explicable only on the supposition that at first the rupture was incomplete, while in others this was accounted for in the closure of the vesical wound by "valvular protrusions" and adhesions, which prevented the escape of urine. An instance is cited of a man who was injured in a fall, and who manifested symptoms which led to the diagnosis of laceration of intestine. The catheter evacuated a large quantity of perfectly clear urine. In twenty-four hours the man died, and the autopsy revealed a large tear in the bladder, into which a coil of intestine had slipped and become engaged. The intestinal tract was found uninjured. There were signs of general peritonitis, and a large quantity of bloody urinous fluid was found in the cavity of the peritonæum. Many cases might be cited to show that the presence of clear urine in the bladder can not be accepted as an evidence of the absence of injury to the viscus. On the other hand, the sudden advent of blood in the urine is nothing more than a presumptive evidence, strong though it may be, of this lesion. The urine may be tinged with blood from simple contusion of the bladder without laceration.

**Diagnosis.**—Important as it is to establish the diagnosis early in all cases, it is even more important to ascertain whether the rupture is intra- or extraperitoneal. In the early stage of the case, when exact knowledge would be most serviceable, such a differential diagnosis is most difficult, often impossible. In a few instances the diagnosis of rupture was established by the accidental passage of the catheter through the vesical rent into the abdominal cavity. If, after entering the bladder and removing perhaps a few drops of urine, the catheter is suddenly felt to slip into a secondary cavity, in which its beak is freely movable, and from which a considerable quantity of sanguinolent urine escapes, it is certain that the laceration extends into the peritoneal cavity, or that the instrument has entered either a subperitoneal pouch, or, if it is situated inferiorly, has passed into an extraperitoneal circumscribed collection of urine. In some cases it was noted that warm water injected through the catheter was felt by the patient in the groin and abdomen, and the escape of the fluid ebbed and flowed with the respiratory movements. As to the significance of peritonitis as an element in diagnosis between intra- and extraperitoneal ruptures, it is nothing more than strongly suggestive of the former. The development of peritonitis in a given case does not necessarily denote a laceration of the peritonæum, as inflammation of this structure may occur in extraperitoneal ruptures either as the direct result of traumatism, independent of the injury to the bladder, or as the consequence of the propagation of inflammation from subjacent parts. When the extravasation is subperitoneal this complication is rather to be expected than otherwise. A further important sign is in the appearance of the urinary infiltration, which in extraperitoneal ruptures is apt to present as a localized or circumscribed swelling, limited perhaps to one side of the body, while in intraperitoneal ruptures the tumefaction is more general, and uniformly globular over the abdomen. The injection of an antiseptic fluid into the empty bladder and the escape of more or less of the fluid injected, is strong presumptive evidence of existence of rupture, provided no time has elapsed for adhesions to form between the seat of the lesion and its annexes. Keen suggests the employment of H gas, and noting whether it distends the cavity of the peritonæum in general, or only the bladder. In extraperitoneal ruptures the injection of fluid would increase the limit of dullness, while H gas would increase the limit of resonance on percussion.

Digital exploration of the interior of the bladder is in some cases an efficient means of diagnosis, especially when the lower part of the viscus is involved. In the male this is effected through a small medium perineal incision made in front of the prostate. In the female it is accomplished readily enough through the short urethra.

**Prognosis.**—This, always grave, will depend upon the situation of the rent, whether it is extra- or intraperitoneal, whether at the upper or lower portion of the viscus, upon the size and character of the laceration, and upon the quantity and extent of the urinary infiltration.

Of 315 cases collected there are reported 52 recoveries. Of these, 42 were doubtless extraperitoneal, and were mostly treated tentatively—i. e., by catheterization, paracentesis, opening of urinary abscesses, some by perineal cystotomy, etc.; 10 were equivocally intraperitoneal, and were treated by laparotomy. Therefore it may be said that but for this operation intraperitoneal ruptures are uniformly fatal. If left to themselves, they terminate fatally in from a few hours to within three days. Few survive the first week. In extraperitoneal lacerations the fatal result is rarely deferred beyond the second week.

**Treatment.**—The foregoing facts in symptomatology will tend to disturb our faith in symptoms; and well they may, if, in appreciation of their unreliability, we shall be led without delay to seek the more positive information which an abdominal incision will furnish; for we must bear in mind that upon prompt surgical intervention the success of the case will depend. If the question still exists between intra- or extraperitoneal laceration, all doubt will be dissipated by an incision through the linea alba, at first carefully avoiding the peritonæum. Thus, if the injury prove to be without the peritonæum, we have afforded a direct means for the escape of the extravasated urine. If the lesion be intraperitoneal, we have taken the initial step to a laparotomy. Two or three cases are reported of catheterization of a subperitoneal pouch through the rent in the vesical wall. This, to be successful, must be done soon after the injury—accomplished readily, without prolonged search for the opening, the extravesical cavity emptied, cleaned, and disinfected, and subsequently treated by the *catheter à demeure*, as presently to be set forth. In certain selected cases, notably when an extraperitoneal rupture is situated near the base of the bladder, perineal cystotomy, or kolpocystotomy, has proved to be an effectual means of affording drainage.

Abdominal section has been performed twenty-eight times—seven extra- and twenty-one intraperitoneal. Of the seven extraperitoneal, three died and four recovered. Of the fatal cases, the bladder was sutured in one. Of those that recovered, Lloyd and Rose treated their cases by the open method, with suprapubic drainage. The other two cases, of Socin-Keser and Garr, the bladder was not completely sutured, but stitched to the abdominal wall. Laparotomy has been performed twenty-one times for intraperitoneal rupture. Of these, ten were successful, nine of which occurred since 1886. Walters and Rose treated their cases by the open method; in all the other successful cases sutures were applied to the vesical rent. The operators were as follows: Walters, Phila. Med. and Surg. Journ., 1859; MacCormac, London Lancet, December 11, 1886, two cases; Walsham, London Med.-Chir. Trans., vol. lxxi, 1888; Hofmokl, Wiener med. Presse, 1886; Holmes, London Lancet, July 23, 1887; Blum, Arch. Gén. de Méd., 1888; Schramm, Wiener med. woch., No. 33, 1890; Rose, Deutsche Zeitsch. f. Chir., Bd. 31, 1890; Mikulicz, given by Rose, Deutsche Zeitsch. Chir., Bd. 31, page 366, 1890. Eleven were unsuccessful. The cases of Willett, St. Barthol. Hosp. Rep., 1876; Heath, Med.-Chir. Trans., London, 1876; Sonnenburg, Centralbl. f. Chir., 1885; Bull. Annals of Surgery, January, New York, 1885; Duncan, London Lancet, August 28, 1886; McGill, London Lancet, November 20, 1886; Teale, London Lancet, June 6, 1887; Keyes, New York, Med. Rec., December 24, 1887; Symonds, London Lancet, May 10, 1888; Lloyd, London Lancet, February 6, 1892; Lane, London Lancet, April 16, 1892.

From a careful study of these cases we may formulate our deductions as follows:

In most of the unsuccessful cases an avoidable cause of failure is apparent. The cases of Teale and Lloyd must be altogether excluded in determining the merits of the operation. Teale did perineal urethrotomy, for the purpose of drainage, from which it is said there occurred "oozing of blood, from which the patient died." The perineal incision was apparently alone responsible for the fatal result. Lloyd's patient died before the operation was completed. Duncan and Sonnenburg did not suture the bladder, and, in the cases of Willett, Heath, Symonds, and Bull, the sutures gave way, or were, owing to some difficulty, not completely adjusted in the first place. In the patients of Willett and Heath, sutures were passed through the entire thickness of the bladder wall—an expedient now known to be a mistake. Lane attributes the death of his patient (also complicated with fracture and dislocation of the pelvis) to pneumonia, for, at the autopsy, both lungs were found to be in a condition of gray hepatization; the wound in the bladder had perfectly healed, and there was no evidence of peritonitis. "Except for the onset of pneumonia, he might have recovered." McGill sutured the intraperitoneal wound, but made an incision three quarters of an inch long on the anterior surface of the bladder, for the purposes of drainage (?). Died from shock seventeen and a half hours after the operation.

It is yet an open question whether an extraperitoneal rent should be or should not be sutured. Certain it is that the open method gives good results in suprapubic cystotomy, and equally certain it is that extraperitoneal wounds do not respond to cystorraphy as readily or as promptly as do the intraperitoneal wounds. In either case, therefore, a tube should be placed in the external wound, so that, if treated by the open method, or the sutures give way, free and uninterrupted drainage may be effected. On the other hand, an intraperitoneal wound once securely sutured, there is no danger of its giving way. Nature begins her work at once, and the quantity of plastic material thrown out in the vicinity of the injury in a few hours is remarkable.

Cystorraphy should be effected with interrupted sutures of fine carbolized silk, with the ends cut short. The stitches should be sero-muscular—that is, each suture should only involve the peritoneal and muscular coats of the bladder, care being taken to exclude the mucous membrane, the edges of which must be inverted. The sutures should be introduced at intervals of not more than a quarter of an inch apart, beginning and ending well beyond the limits of the wound, for it is here where there is most danger of leakage.

When, from the situation of the rent, the application of the sutures is attended with difficulty, the distention of the rectum by means of the air tampon will materially raise the bladder, and bring the lesion within reach. If it is still inaccessible, transverse incisions of the parietal peritonæum on each side, as recommended by MacCormac, will enable the operator to draw the bladder farther out. Before the abdominal wound is closed, the accurate coaptation of the vesical rent should always be tested by moderately distending the bladder with water, and, if there is any escape between the sutures, an additional stitch applied. So firm are the adhesions between the coaptated surfaces that the *catheter à demeure* has been dispensed with in some cases in a few hours after the operation, and the patient directed to micturate by his unaided efforts every two or three hours. Of course, if any impediment exists to the outflow of urine, and it is not feasible to remove the catheter at once, it then becomes an important factor in the treatment, and I believe in such cases the *catheter à demeure* is preferable to the periodical introduction of an instrument; care must, of course, be exercised not to disturb the reparative process already begun. A soft (Nélaton), velvet-eyed catheter open at the extreme end, and secured so that the eye reaches just within the vesical orifice and no farther; to the catheter is attached a rubber tube of sufficient length to reach into a bottle on the floor; the bottle and the tube are filled with carbolized water before the apparatus is attached; thus a vacuum is created in the tube and catheter, and a gentle but continuous aspiration is established, with a suction force depending upon the height of the column of water. The height

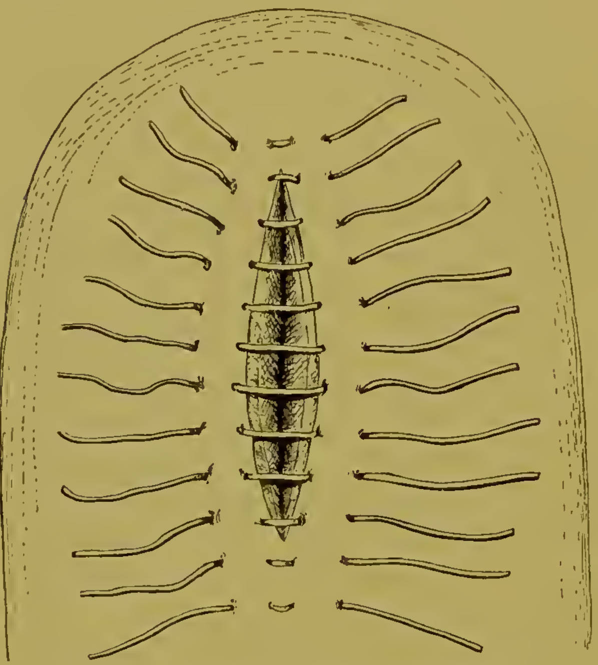


Fig. 1.—The manner of placing the sutures. (After MacCormac.)

of the ordinary hospital bed is sufficient. The bottle is allowed to overflow into a basin, which may be emptied as it is filled without displacing the apparatus.

The clinical and experimental evidence is that peritonitis does not always and at once ensue upon the escape of healthy urine in the peritoneal cavity. This was apparent in the patient of Schramm, with a laceration of 2½ cm. Fifty hours elapsed from the time of the injury to the time of the operation ; and, what is even more significant, the peritoneal cavity was not washed out, but the urine simply soaked up with sponges—the patient's low condition necessitating a rapid completion of the operation. This patient was discharged cured in ten days. In the patient of Lane, too, the blood and urine in the pelvis was sponged out, but no attempt was made to wash out the peritoneal cavity ; yet there was no evidence of peritonitis. That MacCormac, Thomas, Vincent, Esmarch, Billroth, Juillard, Atlee, Homans, Possi, Sonnenburg, and others mention cases of recovery after intraperitoneal injury of the bladder occurring chiefly during ovariotomy, and Schramm in intraperitoneal cystotomy for stone, is suggestive of the fact that the danger lies not in the vesical lesion, but in the presence within the peritoneal cavity of a decomposable and septic fluid; and when this is absent (for they injured the bladder when empty), or when removed shortly after such extravasation has occurred, we may expect a successful termination of an otherwise uniformly fatal lesion. The disposition of intraperitoneal wounds of the bladder to union is so great, that it may be regarded as certain if the edges of the same are accurately adjusted. Therefore, as a rule, the toilet and disinfection of the peritonæum are of primary importance ; this should be made with great care, but as expeditiously as possible ; the cavity of the peritonæum washed out with a one-per-cent solution of boracic acid, warmed to blood-heat, the irrigation being kept up until the fluid returning is perfectly clear. All blood-clots and foreign material must, of course, be removed, but this should be done with as little sponging as possible. In the absence of signs of peritonitis ; the drainage-tube may be dispensed with. When peritonitis is undoubtedly present, the insertion of a drainage-tube may be advisable ; but we must bear in mind that if any fluid exists, it is diffused over the entire abdominal cavity by the movements of the intestines and the suction action of the diaphragm, and never accumulates at one point, unless encapsuled by peritoneal agglutinations.

When, in consequence of the nature, position, and extent of the wound, its successful closure by the ordinary method is doubtful, cysto-abdominorraphy may be practiced—that is, the vesical and the abdominal wounds stitched together. This may interfere with the functional activity of the viscus, endangering the occurrence of cystitis, etc. Indeed, I observed some years ago, in experimenting on a number of dogs, that in each case the bladder had become considerably hypertrophied in a few days, no doubt in consequence of its abnormal attachments, and therefore cysto-abdominorraphy must be a *dernier ressort.* But, as such, it must be kept in mind, for, in the few cases that it has recently been practiced on man, it commends itself for repetition.

# TUMORS OF THE BLADDER.

By FRANCIS SEDGEWICK WATSON, M.D.

**Pathology and Etiology of Bladder Tumors.**—Beyond the influence of the conditions which are stated below, we have practically no knowledge of the causation of bladder tumors. The influence of age, sex, and the liability of certain portions of the bladder to be affected by preference, will be seen in the following :

**Age, with Reference to the Occurrence of Bladder Tumors.**—With the exception of myxoma, which is more often encountered in children, all forms of bladder tumors are more frequent after middle life. Of eighty-nine cases of papilloma collected by the author, the age of occurrence is as follows :

*Papilloma* (eighty-nine cases) :

| | | | | |
|---|---|---|---|---|
| Males, | between | 10 and 20 | years of age, | 1 case. |
| “ | “ | 20 and 30 | “ | 2 cases. |
| “ | “ | 30 and 40 | “ | 12 “ |
| “ | “ | 40 and 50 | “ | 11 “ |
| “ | “ | 50 and 60 | “ | 12 “ |
| “ | “ | 60 and 70 | “ | 21 “ |
| | | | Total, | 59 “ |

| | | | | |
|---|---|---|---|---|
| Females, | between | 1 and 2 | years of age, | 1 case. |
| “ | “ | 30 and 40 | “ | 17 “ |
| “ | over | 40 | “ | 12 “ |
| | | | Total, | 30 “ |

*Cancer.*—In over 100 cases of cancer collected by the author, the youngest patient affected was 30 years of age.

There were 12 cases between 40 and 50 years of age, and the rest were over 50 years old.

*Sarcoma.*—Of 20 cases reported by Hinterstoiser in which the age is mentioned, the youngest patient was under two years.

| | | | |
|---|---|---|---|
| Under | 20 | years of age, | 5 cases. |
| Between | 20 and 30 | “ | 3 “ |
| “ | 40 and 50 | “ | 2 “ |
| “ | 50 and 60 | “ | 6 “ |
| Over | 60 | “ | 4 “ |
| | | Total, | 20 “ |

*Myoma.*—In four cases of myoma, of which two are reported by Guyon, two were in young men, one in a patient aged 30, and another in an old man.

**Sex.**—All computations agree in declaring the greater liability of the male than of the female to the formation of bladder tumors. Pousson, in the April (1889) number of the Jour. Des. Mal. Des. Org. Gen. Ur., reports 141 cases. Of these, 83 were in men, 58 in women. In the Lancet, March 10, 1888, Fenwick states that, in a series of 634 cases of all sorts of bladder tumors, men were found to be affected thrice as often as women. Of 201 cases tabulated by Conner, 133 were in men.

The following figures show the relative frequency of occurrence in the two sexes, with reference to special classes of tumors:

*Papilloma.*—Of 99 cases of papilloma, 66 occurred in men.

*Cancer.*—Guyon quotes Feré as stating that, of 138 cases of this disease, 110 occurred in men. Of 35 cases in Conner's tables, 28 were in men.

*Sarcoma.*—This growth is generally asserted to be more frequent in the female, but the following does not bear out this statement fully: Thus, of 17 of Hinterstoiser's cases, 13 occurred in men. Of 11 cases noted by Conner, 6 were in men. Of 5 cases reported by Küster, all were women; and of 11 cases reported by Sperling, 8 were in women.

**Situation of Bladder Tumors.**—Fenwick (*op. cit.*) states that, of 60 cases of papilloma, 60 per cent were single, and that of these 43 per cent were growing about the right ureteral orifice, and 86 per cent of the single growths occupied the lower zone of the bladder. These observations agree with those of other authors in the main, and it is generally conceded that the lower third of the bladder is much more frequently occupied by bladder growths of all sorts than the upper two thirds. Beyond these facts the etiology of bladder tumors is exceedingly obscure.

**General Pathological Considerations.**—A division of bladder tumors according to their structure, which is convenient and simple, is as follows:

- Benign.
  - Papilloma.
  - Myxoma (frequently called polyp).
  - Myoma.
- Rare forms.
  - Angioma (Virchow's Arch., vol. lxxxvi, Langhaus).
  - Cysts.
    - Hydatid (Fenwick, Path. Soc. Trans., vol. xxxvii).
    - Dermoid.
- Malignant.
  - Sarcoma.
    - Fibro-sarcoma.
    - Lympho-sarcoma.
    - Myo-sarcoma.
    - Round-cell sarcoma.
    - Spindle-cell sarcoma.
  - Cancer.
    - Squamous or flat cell.
    - Glandular.

The various terms, encephaloid and schirrous, etc., as descriptive of gross appearances, may be retained if so understood. The terms epithelioma and alveolar cancer may be better superseded by squamous cell and glandular, though not absolutely corresponding to them.

The relative frequency of benign and malignant growths:

Of 100 cases, 60 were benign (Sir Henry Thompson).
Of 208 " 106 " (Clado).
Of 205 " 138 " (Pousson).
Of 107 " 81 " (Conner).

It is generally agreed that of benign growths papilloma occurs most frequently. Next in frequency is myxoma. Of malignant growths, sarcoma was formerly considered to be a very rare form, but of recent years the number of well-authenticated cases has increased. (See Küster, Volkmann) (Hinterstoiser, Wiener Klinische Wochenschrift, 1890, iii, 304).

## PAPILLOMA.

Any tumor of the bladder may have a papillomatous (villous) surface, but this must not be confounded with the true papilloma. Papilloma may be single or multiple, pedunculated or sessile. Fenwick (*op. cit.*) states that " of 60 cases of papilloma, 60 per cent were single and 40 per cent multiple, and of the 60 cases two out of three were more or less pedunculated; also notes that cancer has been found to coexist in the bladder with benign papilloma."

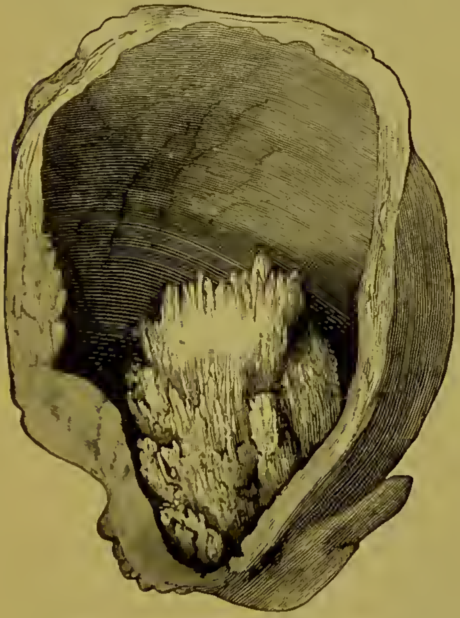


FIG. 1.—(From Thompson.)

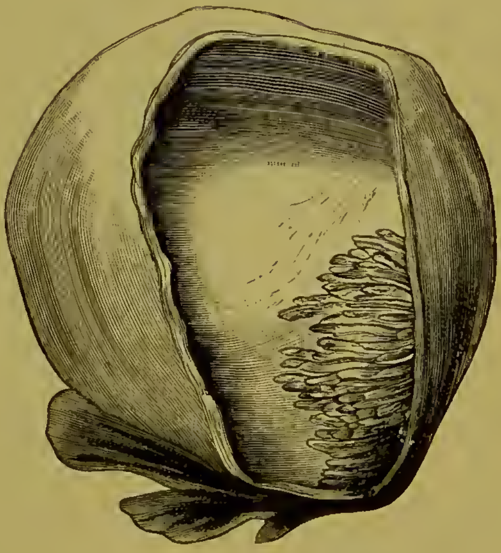


FIG. 2.—(From Thompson.)

A frequent form of papilloma is that in which there is a well-defined pedicle, from the summit of which branch out a number of papillæ bearing heads—a typical cauliflower-growth (see Fig. 1). In contrast to this are the rarer cases in which the papillæ spring separately or in small groups without pedicles directly from the mucous membrane (see Fig. 2). In the latter the papillæ are sometimes very delicate, and float out in fluids like fine threads. In other cases (sessile growths) the papillæ are short and thick, lying close to the surface in clumps. (Plate V.)

The pedicle, when present, varies in length and thickness and structure. It may be as long as an inch or more. It varies in size from that of a knitting-needle to that of the thumb or larger. It is more or less dense, according to its proportion of connective tissue. In color, a fresh growth generally resembles that of the inner surface of the lip. The structure of the papillæ is as follows: Their base is made up of unstriped muscular fiber and connective tissue. From this spring the individual papillæ. Each of the latter consists of a delicate framework of connective tissue, through the center of which run loops of capillary blood-vessels with very delicate walls, lined with endothelium bearing endo-

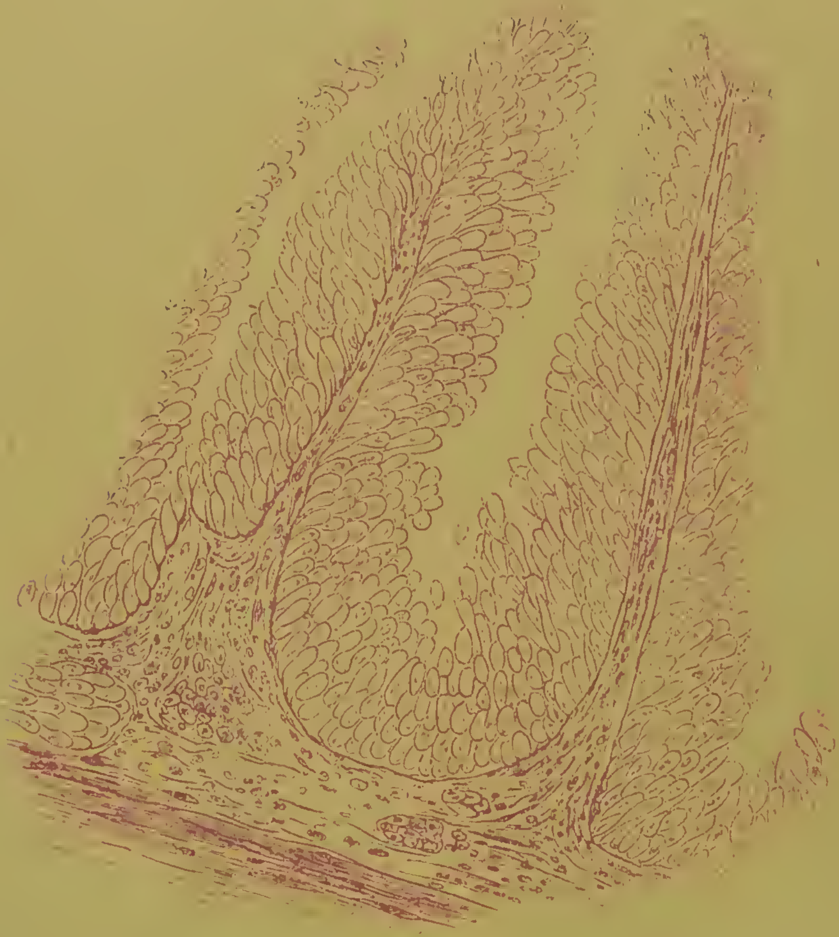
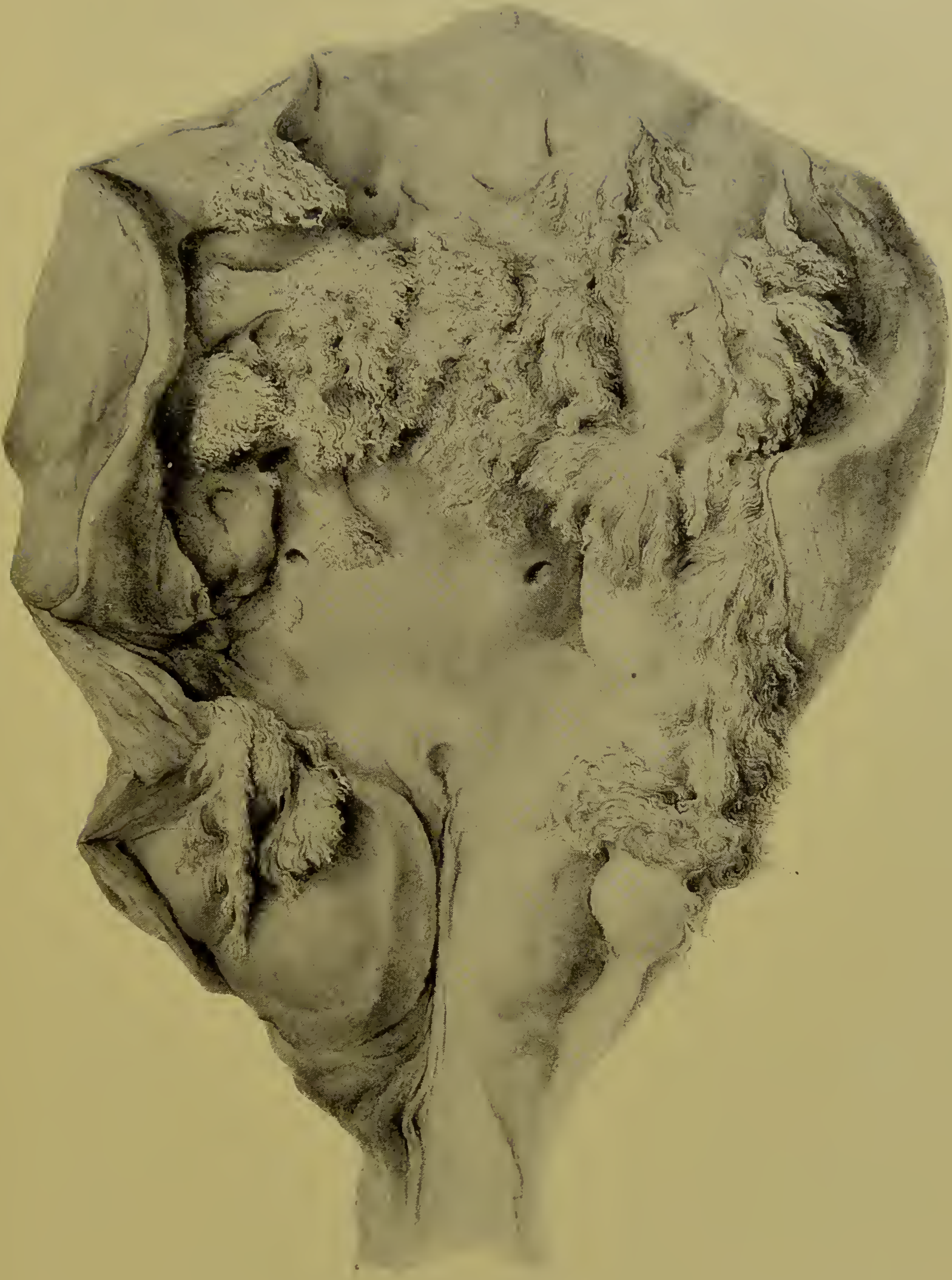


FIG. 3.—Fimbriated papilloma, showing two of the slender papillomatous processes, or so-called "villi." (From Thompson.)

PLATE V.



Multiple Villous Papilloma.
Histologically : True benign papilloma (Albarran).

thelia with large nuclei. Externally each papilla is covered with one or more layers of epithelium of columnar form with large nuclei; these cells are of the same type as the cells of the deeper layers of the normal mucous membrane of the bladder.

The papillæ may be long and delicate, and constitute the chief part of the growth, or the connective tissue may preponderate. To those specimens in which the proportion of connective tissue is very large, Sir Henry Thompson has given the name of fibro-papilloma.

The same author also speaks of a special form of growth which he considers as a papilloma undergoing change into a malignant growth (sarcoma). Of this, he quotes the description of Dr. Heneage Gibbs, who says: "These tumors are characterized by a dense, fibrous groundwork of very irregular growth, and by the presence in this groundwork of variously shaped cells, generally arranged in different groups. In some, there are small, round cells; in others, large, irregular cells. The surface of these growths is covered with columnar epithelium, resembling that of the normal bladder. The one feature which differentiates them from the ordinary papilloma or the fibro-papilloma is the arrangement of the ground substance, and the presence in it of the irregularly shaped cells, which do not belong to the normal tissue on the one hand, or to that of distinct new growth on the other (see Fig. 5).

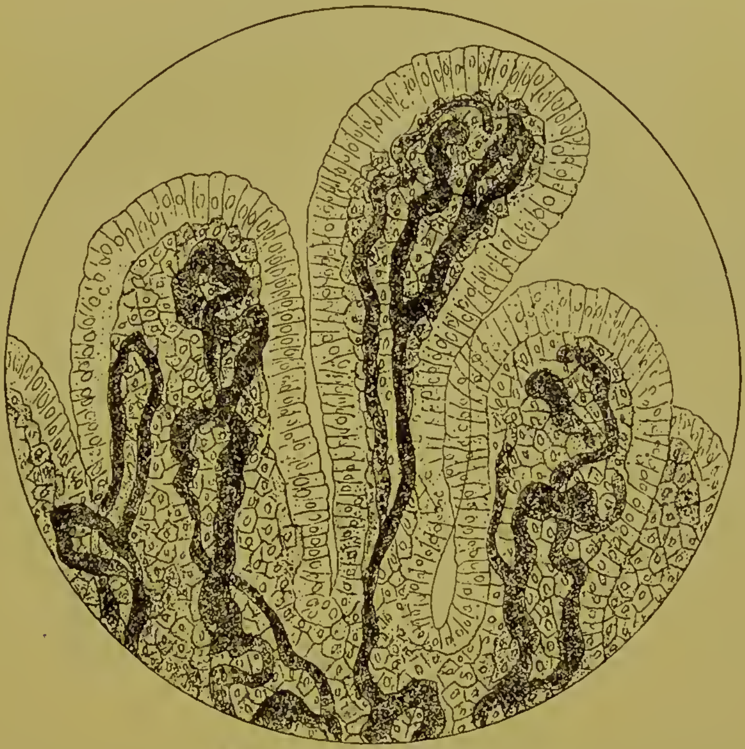


FIG. 4.—(From Ultzmann.)

"To such growths" Sir Henry Thompson gives the name of "intermediate transition varieties."

The possibility of such a change from benign to malignant growth is also asserted by Reginald Harrison, who, in support of this theory, cites a case in which a growth, originally benign, became, after repeated removals, malignant at the end of ten years.

Guyon, on the other hand, combats this idea.

The special characteristic of the true papilloma is that it never invades the submucous tissues. In the form, however, called fibro-papilloma by Sir Henry Thompson, he says the base is made up of unstriped muscular fiber and connective tissue from the submucous tissue of the vesical coat.

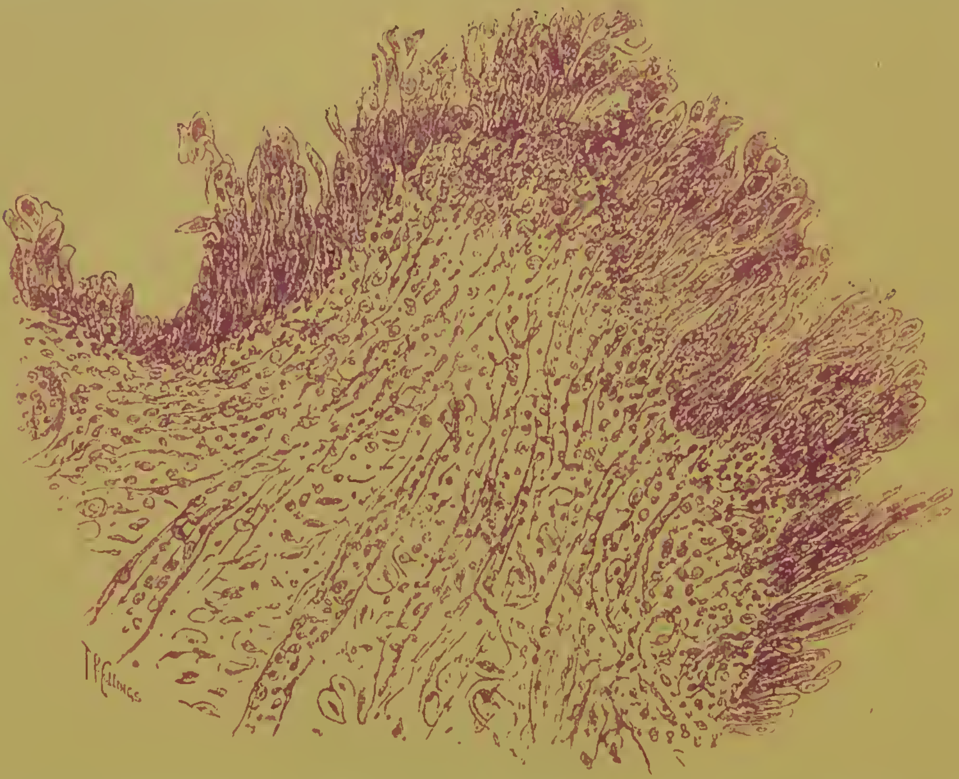
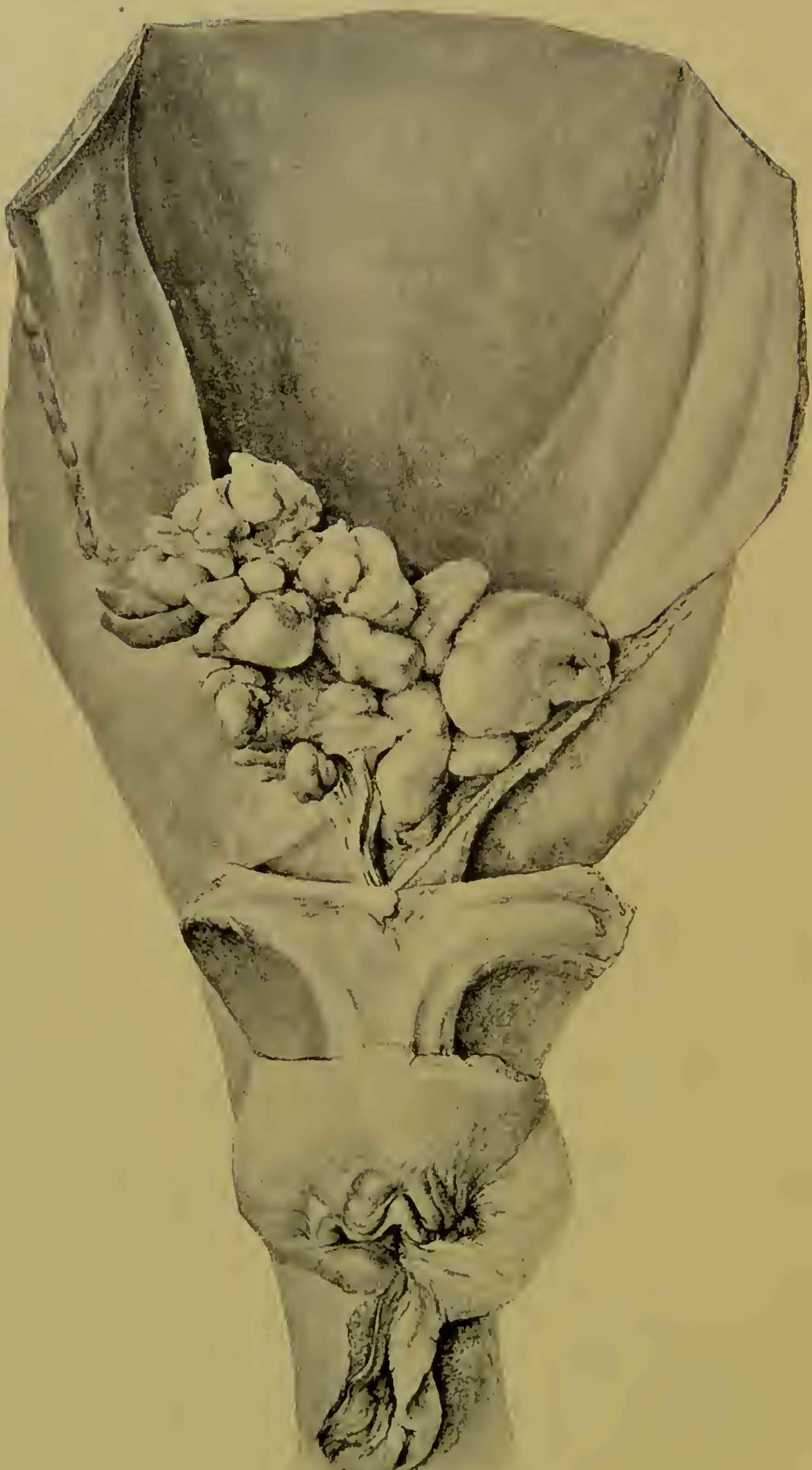


Fig. 5.—Example of the "transitional" type of tumor: showing the ground-substance infiltrated with variously-shaped cells; and numerous blood-vessels running to the surface: one has given way, and effused blood is well shown at the highest point. (From Thompson.)

## MYXOMA (*Polyp*).

The structure of this growth is reported in three instances, by Butlin, Beck, and Shattock, as follows: In one "the growth is composed almost entirely of small, round cells of a lymphoid type, imbedded in a base, homogenous or nearly so on the surface, but becoming more and more fibrous toward the pedicle, until, at the lowest part, fibrous tissue forms the bulk of the growth." Shattock's specimen is described as displaying

PLATE VI.



Mucous Polypi from a Young Girl.
Histologically: Myxo-sarcoma (Albarran).

oval and more elongated cells lying in an abundant substance, either albuminous or mucous. The myxoma is a single growth, pedunculated, and resembles in its gross appearance nasal polypus. It sometimes has a gelatinous texture, sometimes is dense, owing to a greater proportion of connective tissue, in which case it approaches more nearly a true fibroma. Myxoma is essentially a fibroma, which is undergoing or has undergone a mucoid transformation. (Plate VI.)

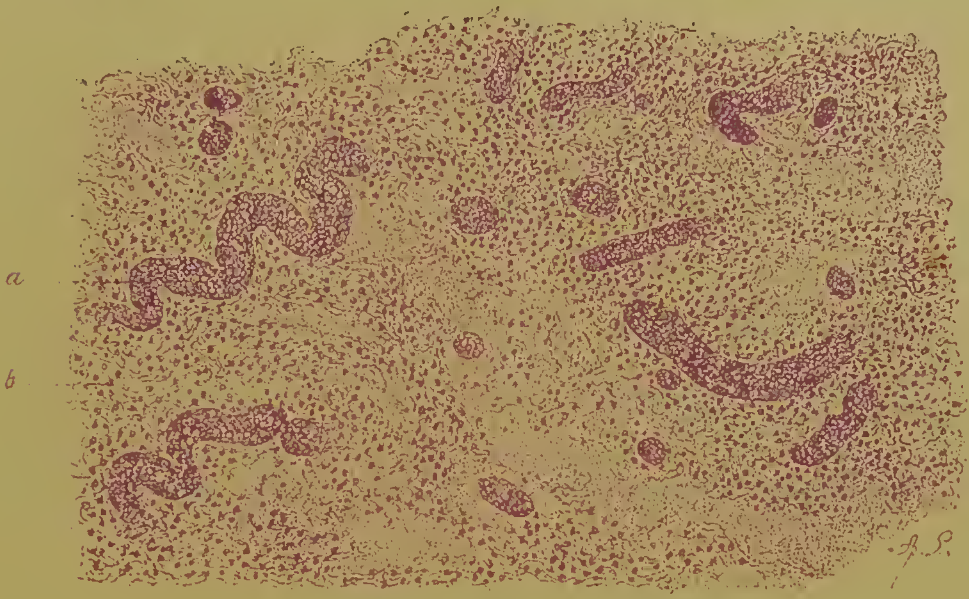


FIG. 6.—(After Albarran.)

These growths occur most frequently in childhood, and it is reasonable to believe that in some instances they are congenital. In one or two cases they have been recognized by the fact of their being spontaneously protruded from the female urethra.

## MYOMA.

This growth is single generally, and shows but a moderate tendency to pedicle formation. Its chief constituent is organic, muscular fiber, intermixed with connective tissue, and in size it has been noted as large as a Tangerine orange.

## CYSTS.

Serous, hydatid, and dermoid cysts of the bladder have in a few instances been recorded.

## CARCINOMA.

The simple and excellent account of these growths given by Reginald Harrison, in his Surgical Disorders, third edition, 1887, page 555, will suffice for their description :

"The epithelial lining of the bladder is composed of a single layer of large-sized, squamous cells, with interlying pear-shaped and round-cell layers. It is also provided with racemose mucous glands, most numerous near the neck of the bladder. It will be seen that we may thus expect to meet two varieties of cancer of the bladder: *a*, the squamous, or flat-cell carcinoma; *b*, the glandular-cell carcinoma. Speaking clinically, the former would be termed encephaloid cancer; while the latter might be encephaloid or schirrous; in other words, hard or soft. These clinical terms give no information relative to the intimate structure of the tumor, but indicate only its rapidity of growth and probable degree of malignancy.

"The vesicle glands might be liable to benign adenoma as well as to malignant carcinoma. So far as I know, only one case of the former is recorded, viz., a case of a papillary growth, removed by Kaltenbach (Langenbeck's Arch., xxx, 1884) from the bladder of a woman aged 44.

"The stroma of a carcinomatous growth, composed of the tissue of the submucous and muscular layers, with more or less round-cell infiltration, is full of alveoli, well packed with epithelial cells, following with more or less accuracy the types of the bladder epithelium. The formation of 'cell-nests' varies much in different specimens, and often in different parts of the same specimen (Fig. 7). Colloid degeneration may occur in primary cancer of the bladder, but is by no means common."

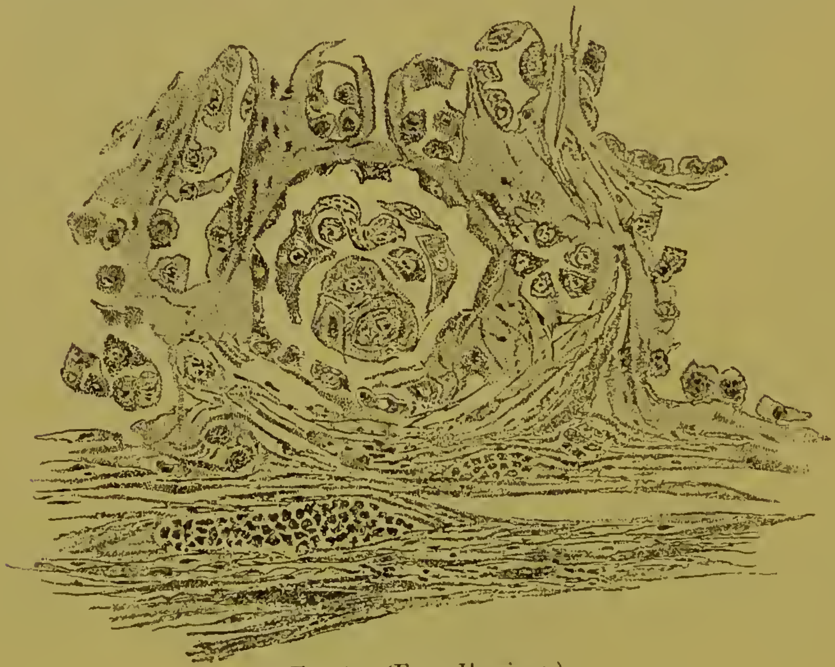
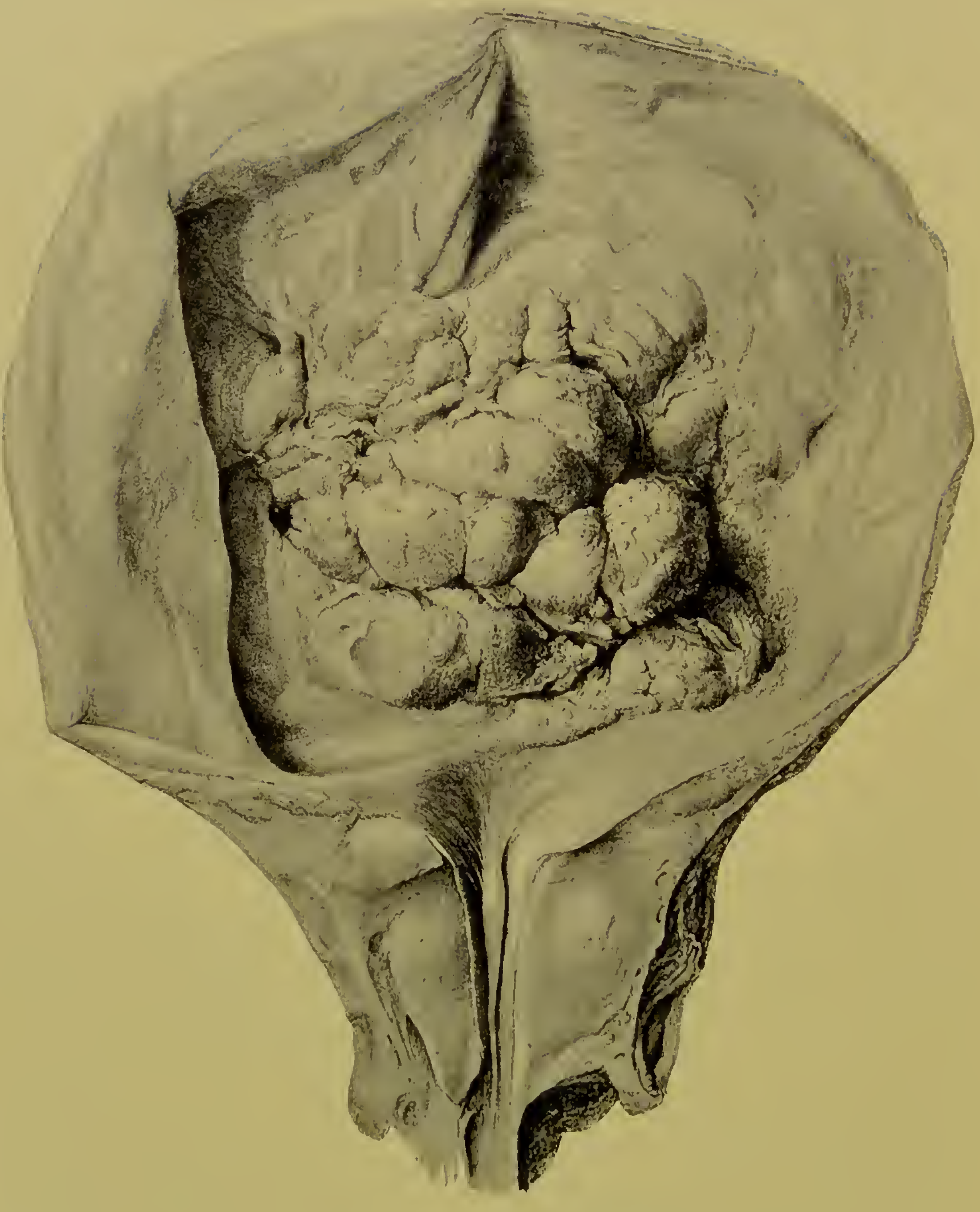


Fig. 7.—(From Harrison.)

The special characteristic of carcinoma, here as elsewhere, is its tendency to invade all contiguous tissues of whatever nature; but the tend-

# PLATE VII.



CARCINOMA.
Histologically: Epithelial cancer (Albarran).

ency to remain local in the bladder for a long period of time is a noteworthy feature. Where direct extension does occur, perforation of the intestine, the involvement of the peritonæum, etc., may follow. The first case in the author's experience was an example of the immense destruction by gradual extension that may take place. In this patient, a man of 66 years of age, the first symptoms of the disease dated back six years. On his death, almost the entire bladder was found to be involved by cancerous growth. The inner surface was covered with papillæ. From the right side of the bladder the disease had extended outward, attacking all the tissues between this point and the right acetabulum, which it had destroyed, allowing the head and neck of the femur to enter the pelvis as far as the great trochanter. The head of the femur about the round ligament was also eroded by the disease.

The surface of the cancerous growth within the bladder may be smooth, the mucous covering seemingly intact, or more or less ulcerated. In form these growths are either flat, with ragged, raised, indurated edges, or sprouting more or less into the bladder cavity, which they may entirely fill. In the latter form they are often pedunculated to a greater or less degree. The surface is not infrequently covered by a papillary growth which resembles in structure exactly that of the benign papilloma. Cancerous growths are sometimes single, and limited to one portion of the bladder; sometimes they exist in disseminated patches. They originate in a majority of instances, as with other growths, in the lower half or third of the organ. (Plate VII.)

Barling (Birmingham Med. Rev., March, 1890) states that in only 3 out of 15 cases of carcinoma of the bladder did extension occur to neighboring organs; and in the same series of cases secondary deposits were found in other organs in 9. Of 49 cases 33 had, as secondary changes, hydro- or pyo-nephrosis, or both.

Clado states that there exists in some cases of carcinoma vesicæ, at a certain period of their development, an adipose layer between the cancerous base and the sound tissue beneath. This Guyon observed while operating in one instance. In the specimens examined by Barling, with reference to this point, he failed to confirm this observation.

The remarkable tendency of carcinoma of the bladder to remain localized for very long periods has been commented on by various writers, and is generally explained by the absence, according to some investigators, or by the meagerness, according to others, of the supply of lymphatic channels in the bladder. Barling (*op. cit.*) quotes Hoggan with reference to this matter as follows: "There is but one set of lymphatic vessels over the bladder except at the trigone. This single layer commences on the deep or mucous surface of the muscular coat, beginning as loops or chains around the smaller arteries or veins within that coat, as though destined to absorb their exudations rather than those of the mucous membrane. These lymphatics concentrate into two main sets, one going back to the neck of the bladder, the other toward the urachus." These are said by the text-books to empty into the internal iliac glands, but Hoggan says this is incorrect. At the trigone there is a second set of purely collecting lymphatics arising in the mucous membrane and connecting with the deeper set. This lack of direct connection of the larger portion of the lymphatic channels with the mucous membrane explains the failure of the neighboring glands to become involved in some cases, or of their tardy infection in others. This also explains the extraordinarily long course of the disease that has been noted.

**Symptoms and Diagnosis.**—The most characteristic and constant symptom of bladder tumors is hæmaturia in a large majority of cases. Exceptionally it is slight, and may be absent during the entire course of the disease, as has been noted by Stein, Guyon, and others. Its absence has been more frequently noticed in cases of cancer, less frequently in cases of papilloma. Hæmorrhage and its consequences may be the only symptoms of importance throughout the disease. As a rule, in benign growths hæmorrhage precedes the occurrence of pain. In malignant disease pain or bladder irritability is apt to precede or accompany hæmorrhage. There have been numerous cases reported, however, in which this was not true, and occasionally in malignant disease pain is absent throughout. Reginald Harrison attributes much diagnostic importance to the relief of pain, when it has been present, which follows an attack of bleeding, especially in malignant disease. This symptom he considers as almost pathognomonic of the affection.

**Special Characteristics of Hæmorrhage from Bladder Growths.**—In general the most distinctive characteristics of hæmaturia from bladder tumors are:

1. Its occurrence wholly independent of any exciting cause, such as exercise. It is not infrequent to see some of the most severe attacks take place during sleep.

2. Its abundance, with the few rare exceptions of cases of hæmorrhage from an ulcerated surface of the hypertrophied prostate, of stone in the bladder, of renal calculus, and of malignant disease of the kidney—the bleeding from bladder tumors is far more abundant than that arising from any other disease in the genito-urinary tract. (One case of gonorrhœal cystitis associated with abundant hæmorrhage has been described by Guyon.) Sometimes the bladder becomes filled with clots, urinary retention and vesical tenesmus resulting.

3. The progressively increasing frequency and abundance of the hæmorrhage as the disease advances.

Occasionally the hæmaturia is constant after the first attack during the entire progress of the malady, the blood flowing in small quantity, perhaps, yet never wholly absent, but, as a rule, intermittence of the hæmorrhage is observed. The length of the periods of remission varies greatly. An interval of seven years has been noted between the first and second attack of bleeding, and in the early stages of the disease many months often intervene. There have been a few cases reported in which the interesting observation of the occurrence of but one or two hæmorrhages has been made, with no recurrence during lifetime. These have been taken as indicating the possibility in rare instances of spontaneous cure either by atrophy or exfoliation, but the evidence is of doubtful value, owing to the lack of positive proof of the existence of the bladder growth.

When blood is present in microscopic quantities, the microscopic appearance of the red globules was formerly thought to furnish evidence as to the origin of the bleeding. It was asserted that, when such bleeding took place from the kidneys, the corpuscles, owing to their longer retention in the urinary tract, took on a spherical form by imbibition, whereas when from the bladder they preserved the biscuit-shaped contour of fresh blood-corpuscles. The fallacy of this latter statement was demonstrated to the author some years ago by a case in which, during repeated examinations of the urine, red blood-corpuscles were invariably found, and always presenting spheroidal form. The origin of the bleeding in that case was thought to be renal, but the post-mortem revealed two tumors of the bladder situated around the orifices of the ureters.

The color of the blood when the hæmorrhage is abundant is generally bright, but may be dark, or, if in clots, dull red. Should any obstructive disease of the prostate or urethra have caused retention in the bladder, sometimes the blood may not be bright. It is, however, decidedly rare to see the light, smoky, or greenish-brown color evenly disseminated through the whole urine that is noticed in connection with some cases of renal hæmorrhage. Evidence of the renal origin of the blood is sometimes furnished (when the bleeding has been sufficient to form clots in the pelvis of the kidney), by the occurrence of attacks of renal colic accompanying the hæmaturia. Also, of course, renal calculus as a cause of the hæmorrhage is to be suspected when there has been a well-marked history of attacks of renal colic. The presence, in addition, of renal casts and crystals of urid acid, the urates or oxalate of lime, makes the probability very great that one has to do with a case of renal calculus.

The presence of renal casts alone in connection with hæmaturia need not mean that the bleeding originates in the kidney; for, as has already been pointed out, many bladder tumors grow about the ureteral orifices, and may cause hydro- and pyo-nephrosis.

Guyon describes a manœuvre for the purpose of ascertaining the presence of a renal tumor in cases in which there is doubt as to the origin of the hæmaturia, which he calls renal *ballottement.* The palm of one hand is laid upon the abdomen above the kidney, while that of the other is placed over the kidney in the back. A quick pressure is then made by the hand on the back, when, he says, the tumor has in several cases been driven against the abdominal wall, giving to the hand resting there a sensation similar to that felt in *ballottement* of the fœtus.

Instrumental manipulation within the bladder is liable to produce hæmorrhage, or increase it if present, in cases of bladder growth, and considerable diagnostic importance is attached to this sign by Reginald Harrison, Coulson, and various writers. It is well to remember that there have been one or two instances of fatal hæmorrhage caused by such instrumental manipulation.

**Pain and Disturbances of Micturition.**—These symptoms, as a rule, in cases of benign growths do not precede the occurrence of hæmorrhage, unless in a very slight degree. In malignant growths, on the contrary, most writers agree that pain precedes or accompanies the first appearance of blood. If a growth be situated near the vesical orifice, it sometimes announces its presence first by interfering with the act of micturition. This was noticed by the author in a case in which a papilloma with a moderate pedicle was situated about the upper margin of the vesical orifice, and first attracted the patient's notice by occasionally interrupting the urinary stream, and in giving rise to a slight twinge of pain at the same time. With malignant growths pain, as a rule, sooner or later, becomes a prominent symptom, and is frequently of a radiating character, felt in the sciatic region, along the front of the thighs, over the symphysis pubis, or about the sacrum and perinæum. Exceptionally pain may be entirely absent throughout the progress of a malignant growth. The pain referred to above is intended to indicate that which is due to the presence of the growth *per se.* Any growth, benign or malignant, may of course have pain associated with it when a cystitis, which is so apt to occur at some period of its course, supervenes, or when hæmorrhage has been so excessive as to cause retention of urine and vesical tenesmus.

Unlike the pain caused by stone in the bladder, or the bladder irritability sometimes noticed in connection with renal calculus, that arising from bladder tumors is generally not increased by exercise. In malignant growths pain is not necessarily associated with ulceration. Guyon mentions a case in which pain was absent while this condition existed. Frequency of micturition, unlike that arising from prostatic hypertrophy, is not characterized by being more noticeable at night.

**Evidence furnished by the Urine.**—The most characteristic and conclusive evidence of the existence of a bladder growth furnished by urinary examination is the presence in the urine of bits of the surface of the growth which have become detached and are passed out in the urinary stream. These, when large, are often noticed by the patient. If not decomposed, they resemble fleshy lumps, varying in size from a pin's head to that of a pea, and look as a bit of the gum would, if detached from the mouth. Sometimes to the naked eye they present the characteristic appearance of finger-like projections floating in the urine. In many instances, however, these fragments are not to be found.

Inasmuch, as has been mentioned already, any tumor, benign or malignant, may have a papillary surface of essentially the same structure in either case, no inference as to the nature of the growth can be drawn from the microscopic examination of such fragments. They are only proof positive of the presence of some form of bladder growth. Such fragments are more commonly thrown off from papillomata and cancerous growths, so that when found they show a probability of the presence of one or the other of these varieties. Hæmorrhage as a rule is associated with the casting off of these fragments. Occasionally the reverse is true, as in the case of cancer reported by Landers, and referred to by Guyon, in which fragments were frequently seen, although hæmorrhage was entirely absent throughout the course of the disease. Besides actual fragments of the growth, the urine very often contains a more or less abundant sediment, in which are found large numbers of epithelial cells of great variety of shapes with large nuclei. Although no forms have been observed which are absolutely different from those of the epithelial cells of the normal bladder in its various layers, and while, therefore, theoretically there is no reason why they should not be also found in any disease in which desquamative or deep-seated ulcerative processes are present, nevertheless, the author has failed to find them in such quantities and so repeatedly in the urinary examinations of any other conditions as in those of bladder tumors, and therefore considers that they are of distinct diagnostic value. In this opinion he is confirmed by Prof. E. S. Wood, of Harvard Medical School.

As has already been pointed out, secondary changes in the kidney or its pelvis are liable to follow upon the presence of a bladder tumor, especially if it be seated at the ureteral orifice. In this case casts and renal epithelium are likely also to be found in the urine.

**Physical Examination. Rectal Touch.**—It is rare to be able to detect a benign growth, unless it be very large and dense, by rectal touch. Cancerous growths, on the contrary, can usually, except in their early stages, if situated within reach of the finger in the rectum be felt as areas of induration, and by giving a sense of increased resistance.

Any considerable hypertrophy of the prostate will make a rectal examination unavailing. The rectal examination should be made with the bladder nearly or quite empty; for if full, a growth not situated near the vesical neck and upon the floor of the bladder will be carried beyond the reach of the finger.

In individuals with thin abdomens who have a large and dense tumor of the bladder, bimanual examination with one finger in the rectum and those of the other hand pressing deeply in above the symphysis pubis, may assist in the detection of the growth. Otherwise, it is not of much assistance.

**Instrumental Exploration of the Bladder.**—The failure to detect a bladder tumor by exploration with the searcher or sound is no evidence of its absence, for, unless the tumor be prominent and dense and resistant, no characteristic sensation is given to the fingers holding the instrument; rugæ or projecting portions of a hypertrophied prostate may lead to a false inference that a tumor is present. In cases, which are not very infrequent, in which the surface of a tumor is covered with a deposit of phosphatic salts, the error is likely to be made of mistaking the condition for a stone. Such instrumental examination, therefore, should be discarded because of the far more accurate means at our disposal.

Some writers have advised that an attempt should be made, with an instrument of catheter form, furnished with a large eye, having a moderately sharp edge, to detach fragments of the growth in suspected cases by active movements of the instrument within the bladder. This practice the author considers most injudicious, for the reason of its liability to produce hæmorrhage, or to give rise to a cystitis, to which condition such cases are peculiarly liable upon interference, and also because it is rendered unnecessary by the cystoscope.

**The Cystoscope.**—Among the various writings upon the cystoscope and its uses, a most satisfactory exposition of the subject is in the admirable work of Fenwick (on the Electric Illumination of the Bladder and Urethra, as a means of diagnosis of obscure vesical urethral diseases. A. Churchill, 11 New Burlington Street, London, second edition, 1889). What follows is taken almost wholly from this author. It is out of place in this article to enter into the history of the gradual development of the cystoscope, from its original conception by Bozzini, of Frankfort, in 1805, to a practical instrument constructed by Desormeaux, in 1853, and down to the instruments in their more approved forms now in use. Without entering into a discussion of the claims of authorship of the modern instruments over which some dispute has arisen, it is fair to say that Dr. Max Nitze should be credited with being the practical inventor and introducer of the modern instrument; that to the instrument-maker, Leiter, of Vienna, also belongs credit for having produced a technically admirable instrument following Nitze's ideas.

The instruments best suited to their purpose that are in use to-day are the Nitze "Incandescent-lamp Cystoscope," the Leiter "Incandescent-lamp Cystoscope," Fenwick's Cystoscope with a perforated hood to keep the lamp cool, and Whitehead's Cystoscope for use through a perineal *boutonnière.* (A detailed description of the instruments is given elsewhere.)

Schall, of Wigmore Street, London, has a battery for cystoscopic illumination, which has given entire satisfaction to the author; it has the practical advantages of a dry-cell battery, and in the use of it during one year it has proved wholly reliable. It is a six-cell battery, the cells intercommunicating by silver wires, and also connecting with the cystoscopic wires. There is no lever, the plates being sunk constantly in the fluid of the cells. The intensity of the current is regulated by a rheostat, which is cleverly arranged so as to form a part of the handle by which the battery is lifted. The cells are sealed with a metal cover, which is pierced by a pin-hole opening only, and so the one great inconvenience of the fluid-cell batteries, such as that of Leiter, for example, is done away with. The battery measures only about eight inches by five, and is light and easily carried.

**Objections to the Use of the Cystoscope.**—Two objections might reasonably be made to the use of the incandescent-lamp cystoscope:

1. *Burning the Mucous Membrane.*—Although the heat emitted by the cap or hood, with its contained incandescent lamp, when in action, is not so great as that given off by the platinum-wire lamp, yet it does become very quickly hot if it is allowed to burn in air instead of under water. Thus, it becomes warm after four seconds, unbearable after ten, and scorches the skin severely after fifteen seconds. If, however, the tip of the instrument is placed in water, the heat is rapidly absorbed, and the cap or hood remains cool, and may be touched with impunity, even after an hour's use. This is exactly what happens in the bladder, for the urine carries off the heat of the lamp as fast as it is formed. "They may be burned for an hour in a male bladder, holding seven ounces of fluid, without perceptibly raising the general temperature" (Brenner). It is therefore a *sine qua non* in electric cystoscopy that the bladder shall contain five or six ounces at least of urine or water. Now, although the urine or water absorbs the heat of the cap, if it be freely surrounded by the medium, yet this does not happen if the cap be held in contact with the vesical wall.

The perforated hood, which is adapted to my own (Fenwick's) cystoscope, does away with much of the danger of burning the mucous membrane, for the water circulates through the small holes, and is in direct contact with the lamp.

2. *Another objection is the breakage of the lamp.* It might be feared

that the contact of the water with the heated hood would crack the small lamp, or might even split the rock-crystal plate which covers the aperture for light. If there was any chance of such an accident happening, it would be fatal to the use of the cystoscope altogether. The fear is happily quite groundless in the Leiter pattern. If an ill-made lamp should shiver—and I have never heard or known of such an event—it would still be inclosed in a metal hood, the aperture in which is occupied by an unbreakable plate of rock-crystal two millimetres thick.

Mr. Whitehead, of Manchester, has introduced an improvement in the size of the instrument. The cystoscope which Mr. Leiter has made at his request is identical in principle with the new pattern, but of 40 F. gauge instead of 22 F. The advantages of this increased size lie in the wider field of vision obtained, and the employment of a larger incandescent lamp, with correspondingly increased brilliancy of light. The window of observation in the new instrument is six sixteenths of an inch square, at least twice the area of that in the original one, and the lamp is double the size. Mr. Whitehead introduces this instrument through a median incision in the membranous urethra. Mr. Whitehead speaks well of the instrument, saying that "the illumination and the field of vision left nothing to be desired." The innovation is a valuable one, although it directly traverses the *raison d'être* of cystoscopy, which is that it affords a visual diagnosis without a cutting operation.

It at once suggested the employment of a larger instrument upon females. This has proved invaluable, for, with slight dilatation of the female urethra, a No. 40 French cystoscope is easily passed. Leiter has made, at my suggestion, such an instrument, to be used exclusively for the female bladder. Its shaft is four and a half inches in length.*

Even with a slight experience of this larger size of incandescent-lamp cystoscope, one can conceive that it will be of the greatest value in that class of cases in which the exploring finger can not reach the bladder through the membranous urethra by reason of certain mechanical obstacles, such as (1) the stoutness of the patient, by which the depth of the perinæum is increased; (2) an enlargement of the prostate, by which the bladder is pushed farther from the surface; (3) a considerable narrowing of the pelvic outlet, which prevents the hand being well pushed into the perinæum.

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* The teaching of Dr. F. N. Otis, of New York, viz., that the average male urethra has a caliber of 32 (French scale) after the meatus has been freely divided, and that there are but few cases in which it is smaller than this, is so generally accepted in America, that there is no reason why the cystoscope-tube should not be made of that size, or at least of a 30 caliber, and used through the male urethra without opening the perinæum, in the absence of stricture or prostatic hypertrophy.—(Author.)

The management of the cystoscope requires, as we have said, but little technical knowledge, but the power of gentle and purposive manipulation of the instrument when in the bladder can only be acquired by extensive practice. Those who are constantly in the habit of using the calculus sound, and of passing solid steel instruments or metallic catheters, will have nothing to learn in the actual introduction of the cystoscope into the bladder, for the latter is as easy as the former; but the pointing of the beak, and due rotation of the instrument, so that a certain patch of the bladder wall may become illuminated and examined, requires a great deal of practice and much patience. It is wise to use the instrument freely on the dead subject first, for we gain thereby a more rapid knowledge of the capabilities of the instrument than we can expect to acquire on the living.

Again, although we may become rapidly proficient in placing the light, it is far otherwise in the just appreciation of what is seen. A stone or needle incrusted with phosphates, or a typical growth, is as readily recognizable by a novice as are some well-marked conditions of the retina, tympanum, and larynx, when examined by means of the ophthalmoscope, otoscope, and laryngoscope.

There are, however, certain conditions of the mucous membrane which are at first exceedingly puzzling, and which require some experience to determine their nature. One of these pitfalls consists in swollen mucous membrane; another in rugæ of the mucous membrane of the insufficiently dilated bladder simulating outgrowth from the wall. Lastly, it is very difficult to appreciate the exact size of the object we examine. The size of the object as seen through the instrument varies according to the distance of the prism from it. If the prism be near, the object is magnified, and we are deceived as to its proportions; if the prism be withdrawn, the opposite effect is produced.

The cystoscope fails under certain conditions: 1. It can rarely be passed without undue violence in patients the subjects of irregularly enlarged prostates—i. e., in which the prostatic canal is very devious, and blood becomes smeared on the window and mixed with the urine in the bladder. An ordinary enlarged prostate offers but little impediment to the introduction of the instrument, but it is impossible to examine the pouch behind the prostate if that depression is deep. Nor can the base be thoroughly searched if the intravesical prostatic outgrowth be large. 2. Stricture of the urethra, of course, offers an impediment to the passage of the cystoscope. This obstruction can easily be removed by dilatation. It may happen, moreover, that in dilating the stricture to facilitate the introduction of the instrument, we may remove the cause of the obscure symptoms which have suggested the electric-light exploration of the bladder. If the meatus be small, it can easily be cut inferiorly, under cocaine, to the proper size by a touch of a blunt-pointed bistoury. 3. If the urine contain blood or pus, the wall can not be distinctly made out, for the light seems to be placed in a red or yellow fog, and everything is obscure; this is, however, generally obviated by washing out the bladder and replacing the murky medium with clear water. 4. It will be found that the cystoscope is difficult to work in contracted bladders, or in those in which the capacity has been greatly diminished by pressure from without. 5. Occasionally spasmodic contraction of the bladder (especially in cases of tuberculous or other ulceration) will not allow a sufficient amount of water to be tolerated. Cocaine or anæsthesia usually overcomes this difficulty. 6. Certain deformities, such as ankylosed hip, a rickety pelvis, or a kyphotic spine, will give the observer some difficulty in approaching the ocular end with his eye; a little management of the head is needed in these cases to obtain a good view.

Summing these points up briefly, we may say that there are three conditions indispensable for the employment of the cystoscope: 1. The urethral canal must have a a caliber of 22 French catheter gauge. 2. The bladder must have a capacity of at least four ounces. 3. The water in the bladder must be translucent, and ought to be perfectly transparent.

**Summary of Rules for using the Instrument.**—1. See that the bladder contains at least six ounces of clear fluid. 2. Regulate the lamp beforehand, and do not start the lamp until the elbow is well within the bladder. 3. Do not keep the cap in contact with the wall. 4. Let the manipulation be gentle and purposive. 5. Let the instrument remain half a minute in the bladder after the current has been shut off, in order to completely cool the hood before you withdraw. 6. Let the base of the bladder be examined first; for the inferior zone of the bladder is to vesical endoscopy what the optic disk is to ophthalmoscopy—the most important area in the examination. It is to the inferior zone that the cystoscope is first directed, for it is this section of the bladder which contains or conceals for the most part those diseases which rank as "obscure."

(The special appearances of disease are described in the article on "Cystoscopy.")

**The Value of the Electric Cystoscope.**—The value of the electric cystoscope may be estimated in various ways. The instrument can either afford us a clearer insight into pathological conditions of the vesical mucous membrane, and enable us to watch the progress of the disease and the behavior of the same under varying forms of treatment; or it may allow us to control our clinical observations and speculations by direct visual research, and rightly to assign the more prominent symptoms to definite causes; or, finally, it may at once elucidate for us the cause of obscure symptoms of urinary disease, of which we otherwise could obtain no certain clew without a cutting operation.

The following three illustrations, taken from Albarran, give an impression of the cystoscopic picture of three forms of bladder tumor.

**Digital Exploration.**—The last measure at our command for arriving at a diagnosis, and as opening the way to operative treatment (in which latter connection it will be considered later), is digital exploration of the bladder through a perineal *boutonnière.*

Although this manœuvre had been previously performed by many surgeons, Sir Henry Thompson should nevertheless be credited with having proposed and established it as a diagnostic step in cases of bladder tumors, and so supported it with ample experience as to give it a definite and valuable place among the surgical procedures in this class of cases. This he did in 1882 and 1883. His proposition was to employ this manœuvre only in cases of obscure bladder disease in which other means for diagnosis had proved unavailing. The urethra should be opened in the usual way at its membranous portion through the perinæum, sufficiently to admit the index-finger, which thereafter is passed through the vesical sphincter until its tip lies within the bladder, which for the purpose of exploration should be empty. By then pressing the fingers of the other hand deeply in above the symphysis pubis upon the summit of the bladder, the interior of the latter can, by rotary movements of the hand which presses upon it from above, be made to pass

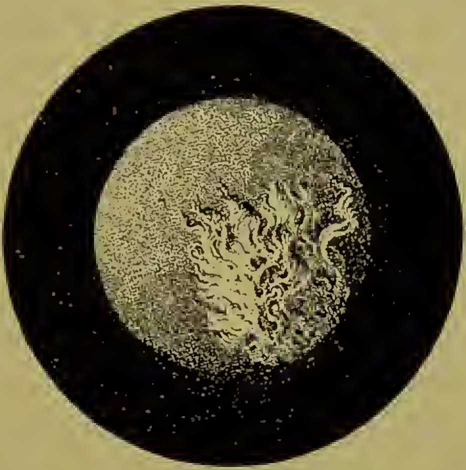

FIG. 8.—Villous epithelioma. (From Albarran.)

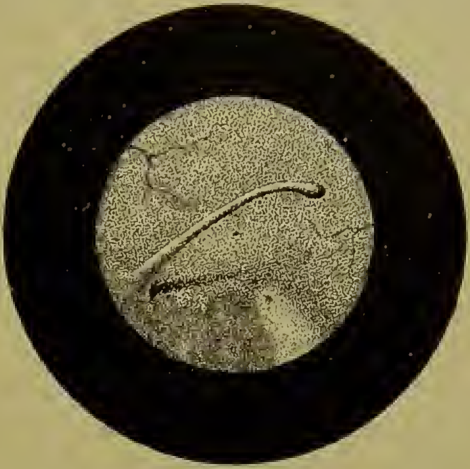

FIG. 9.—Small, smooth tumor, with long pedicle. (From Albarran.)

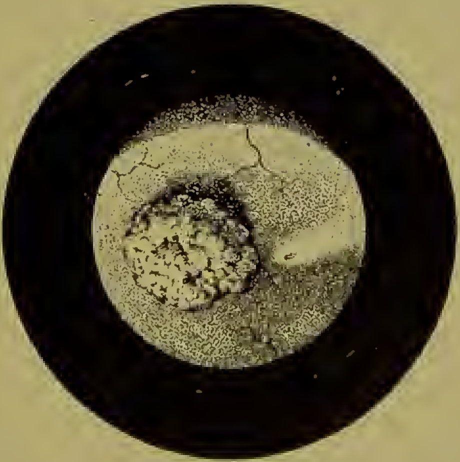

FIG. 10.—Lobulated epithelioma (From Albarran.)

over the tip of the finger lying in its interior. The exploration may be supplemented by a finger in the rectum. In this way the entire cavity may be brought within the reach of the examining finger. By this means Sir Henry Thompson was led in a considerable number of obscure cases to a certain diagnosis of bladder tumors, and in some to their subsequent successful removal, inasmuch as he advocated at that time for the majority of such cases their removal through this wound already made.

The procedure was thus of value, not only for the diagnostic but in a certain proportion of the cases for operative purposes. This is one of its chief advantages, provided one wishes to attempt removal of the growth through this road; and Sir Henry further stated that, if the growth was of such a nature as to preclude the possibility of its removal in this way, the *boutonnière* in nowise deterred the surgeon from proceeding immediately to the high cut in such a case.

The sense of touch he also considered as practically unerring in the detection of bladder growths. The objections to be urged against this manœuvre are, that it is incapable of being employed in any case in which there is a considerable bilateral hypertrophy of the prostate or a very narrow outlet to the pelvis. A number of examples of the failure of touch to detect growths are on record; also, among others, the following case of the author's:

The growth was in this instance a papilloma made up of fine, delicate papillæ which sprang from a very ill-defined base about the size of a half-dollar between and above the ureteral orifices. The finger wholly failed to appreciate its presence, which, however, was established by scraping at hazard with the curette, which brought away an unmistakable bit of new growth, and enabled the operator thus guided to accomplish its entire removal successfully.

Where the cystoscope has satisfactorily demonstrated a tumor, it is unnecessary to resort to digital exploration. The author is in accord with Sir Henry Thompson's expressed opinion as to the harmlessness, however, of the *boutonnière* operation in such cases, and it may serve a useful purpose as an extra means of drainage subsequent to the high operation.

In the author's belief, however, the special value of digital exploration as described is in those cases in which there has been a failure to make a diagnosis by the usual means, or by the cystoscope, owing to the conditions which render impracticable the successful use of the latter instrument, or through failure to see the growth even in cases in which the conditions are favorable, should such an occurrence happen. Under these conditions, and in the belief of the existence of bladder disease of unascertainable nature, the digital exploration should be resorted to, and it takes a place of much value, involving almost no risk, as the last of the steps in making a diagnosis. Sir Henry Thompson's recent views in regard to the value of cystoscopy and digital exploration are expressed thus in the Medical Press and Circular, August 13, 1890: "But it may be said that the diagnosis may be readily established by means of the Leiter cystoscope. I long ago tested its value. Let me say, first, that the employment of it in the cavity of the bladder involves much irritation in some cases, far more than that which follows the use of the sound.

"Secondly, that in the presence of a tumor which the slightest mechanical contact causes to bleed the observation is mostly an imperfect one.

"Thirdly, that the instrument is rarely necessary to determine the fact of the tumor's presence, that being ascertained in nine cases out of ten by the ordinary methods.

"Lastly, it is assumed to furnish the means of insuring a view of the growth which shall enable the operator to determine whether it is pedunculated and easily removable, or the reverse.

"In regard to this important matter I admit that the object may be obtained, but in the majority of cases I am certain it can not be thus decided, as when the tumor is not seen in profile, and when the bleeding occasioned permits only an imperfect view, a far more accurate idea can be obtained by 'digital exploration,' which never produces a cystitis, becoming chronic and confirmed, which unhappily too often follows prolonged manipulation with a rigid cystoscope in the diseased bladder of an elderly patient."

The following comparison, as opposed to the above view of the value of cystoscopy and digital exploration, is made by Fenwick:

"1. Digital exploration is a cutting operation, needing confinement to bed. Electric cystoscopy does not need such confinement, although it is wiser and safer to have the patient in bed for the rest of the day. I have used the cystoscope in out-patient and private practice, favorable cases being examined without any preparation. Certain cases, however, as will be seen in the third statement, are not examined except when in bed.

"2. The former operation needs an anæsthetic. In the latter it is not absolutely necessary. In the greater number of cases I have neither used gaseous narcosis nor cocaine. I employ anæsthesia (*a*) in females for delicacy, (*b*) in tuberculosis or similar cases where the prostatic urethra is extremely sensitive, (*c*) in order to make a leisurely diagnosis of a discovered growth, so as to determine the expediency of operating.

"3. Digital exploration is not absolutely free from risk or hæmorrhage, and frequently either a troublesome fistula or a hypersensitive scar is left in the urethra. Cystoscopy is in most cases, if it be gentle and purposive, as free from risks as routine catheterism or sounding. There is, as every surgeon is aware, some risk in the first introduction of any instrument through the deep urethra—a risk which must not be made light of. There is also some danger to be incurred in washing out the bladder for the first few times if residual urine be present; and, lastly, there are certain diseases, such as tuberculosis of the urinary tract, which resent at once any instrumental interference.

"The surgeon must therefore select cases for routine observation with care and judgment—those which his knowledge of the idiosyncrasies of urinary disease can assure him will be suitable. He must regard the cystoscope in the same light and with the same deference that he should regard the bougie, the sound, or the catheter, for, as Sir Henry Thompson has so tersely and so wisely expressed it, 'The introduction of an instrument is more or less an evil, never to be resorted to unless a greater evil be present, which its employment may probably remedy.'

"I myself avoid using the cystoscope if the following conditions are present: (1) Obvious tuberculosis of the urinary tract; (2) traumatic renal hæmaturia of recent origin; (3) irregularly enlarged prostates; (4) residual urine due to ataxia; (5) phosphaturia.

"I include traumatic renal hæmaturia on the strength of a fatal case which occurred quite recently in my own practice.

"4. In most cases the educated eye is to be preferred to and relied upon rather than the finger.

"5. It must be readily admitted that digital exploration allows of the bladder being subsequently drained, but the rest thus afforded is not always necessary, nor is it always productive of benefit.

"A belief has been expressed that the early use of the cystoscope in hæmaturia will tend to limit the size and number of vesical papillomata by enabling us to detect and remove these and other growths in their very infancy.

"I do not quite agree with this belief, for a careful examination of the histories and pathological specimens of vesical growths has convinced me that vesical tumors do not obey a fixed law of development, for they do not increase in size *pari passu* with the duration of symptoms. The increase depends upon the character of the growth, its position in the bladder, and its method of attachment to the wall. It is therefore possible for a growth to attain a considerable size before any evidence is afforded of its presence. It thus lies 'latent' until a chance congestion or accident develops the characteristic hæmaturia."

**Duration of the Disease, and Prognosis.**—In the majority of cases of both benign and cancerous growths the progress of the disease is usually slow. Guyon refers to an instance of benign growth in which characteristic symptoms had been present for twenty-seven years before death occurred, and other instances, in which the nature of the growth was presumably cancerous, in which the disease had lasted fifteen years before death. These are, however, exceptional. It is probably fair to assume that the average duration of the disease after the appearance of the first symptoms is from three to five years.

On the other hand, exceptionally, a patient may die within a few months, from the presence of the bladder growth. In such cases death is usually due to frequent and repeated hæmorrhages alone, or from the effects of cystitis and nephritis superadded.

Cancerous growths kill the patient by exhaustion, hæmorrhages, or by extension or metastasis to other organs. Ordinarily the patient fails slowly, often recuperating, however, wholly in the intervals between the attacks of bleeding in cases of benign growth, if the intervals are sufficiently long.

No definite prognosis as to the duration of the disease can be given. It can only be said that, practically speaking, death is the inevitable result in all cases of bladder tumors if left to themselves. The prognosis after surgical operation will be dealt with in considering the operative treatment.

**Treatment.** **Palliative Treatment.**—Palliative treatment, it may be said at once, is wholly unavailing so far as cure is concerned. Some measures, however, may be employed with temporary benefit to check hæmorrhage, and perhaps by so doing enable the patient to recover sufficient strength to undergo surgical operation, if appropriate. For this purpose in the author's experience long-continued irrigations of the bladder through a soft-rubber catheter with very hot water, 110° to 120° Fahr., best accomplishes the purpose. The use of strong astringents and of styptics within the bladder can not be advised, as they are liable to produce tough coagula, and to render the evacuation of the bladder more difficult than it already was.

In cases in which there has been already a severe hæmorrhage and a coagulation of blood within the bladder, the author believes that it is wiser to allay vesical tenesmus and pain by the administration of opium rather than to attempt to remove the clots by breaking them up and washing them out with large catheters or evacuators. The latter practice is likely to result in renewal of the bleeding as fast as the clots are removed, whereas the pressure caused by the filling up of the bladder with clots tends to check the hæmorrhage after a certain time of its own accord, and in the course of a few hours disintegration of the coagula and their evacuation will occur spontaneously.

If this expectant treatment, however, be followed in such a case, a careful watch should be kept to see that the flow of blood and retained urine in the bladder does not increase to a dangerous point, which can be determined by frequent examinations of the organ above the symphysis pubis. The patient's general condition also furnishes a satisfactory guide. The occurrence of such an attack of bleeding should lead to as speedy an operative treatment as the patient's condition will allow.

Any palliative measures, such as the administration of drugs by the mouth or by the rectum, are of too little value to notice.

**Operative Treatment of Benign Growths.**—It may be stated as an axiom that in all cases of benign tumors removal of the growth should be undertaken at the earliest available moment after the establishment of the diagnosis, except in the presence of definite contra-indications. (The question of operative measures in cases of malignant growth will be considered under a separate heading.) The only contra-indications in cases of benign growth that seem worthy of much consideration are such exhaustion of the patient as to render the issue of the operation hopeless, or the presence of grave renal disease, or some other complicating malady which on general principles would contra-indicate any surgical operation.

Although isolated instances of the removal of bladder tumors occurred in the hands of various surgeons from the time of Corvilard, who in 1639 removed a bladder tumor by the lateral cut for stone, down to 1880, the operative treatment of this condition practically dates from about the latter year. Since that time this condition, which formerly was considered as among the rarest of diseases, has been shown to be much more common than it was supposed to have been, and within the last eleven years the number of cases observed has been very large, and the number of those operated upon has been sufficient to furnish a series of data upon which to base satisfactory conclusions as to the results of treatment by operation in the various classes of tumors, and the relative advantages of the different methods.

For the removal of growths from the bladder one of two routes is most commonly employed: that through the perinæum, as proposed in 1883 by Sir Henry Thompson, and the suprapubic. In women we have in addition colpocystotomy. And there have also been proposed by Langenbuch and Helferich special operations. That by the perinæum is described by Sir Henry Thompson as follows: (The urethra is opened in the median line, as described under "digital exploration," and the finger is pushed into the bladder and its interior explored.)

"When the survey of the vesical cavity has been completed, the operator has to determine the following question: Am I capable of completing my design of removing the tumor before me wholly or partially, as the case may be, through the incision made, or should I do so more efficiently through a suprapubic opening? For it may be taken for granted that a case may occasionally present itself in which the latter course may appear to be preferable, and if so there is no reason whatever for not selecting it. The perineal incision made will not add to the risks of the case, and it has afforded that most important element, the means of obtaining an exact diagnosis.

We shall now consider the means which it is desirable to employ in order to remove the tumor, when, having examined it fully, we have decided to make an attempt through the perineal opening. First, if we have the good fortune to encounter a single growth, polypoid in form, and therefore with a pedicle of no great width, there need be no hesitation whatever in introducing a pair of forceps into the cavity of the bladder, and employing them there without any aid from the operator's finger. The forceps to be used for this purpose are to have rather wide and serrated margins where the blades meet, so as to crush but without any power to cut the tissues seized. These forceps should be provided in different forms. The first or simplest pattern should be straight, resembling an ordinary lithotomy forceps; others should be curved for seizing tumors which are situated laterally and near to the neck of the bladder, in which last-named position the straight forceps are powerless to grasp the tumor.

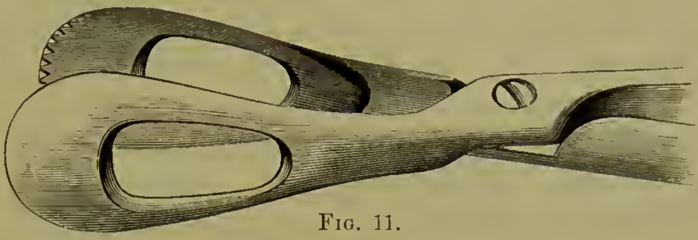
Fig. 11.

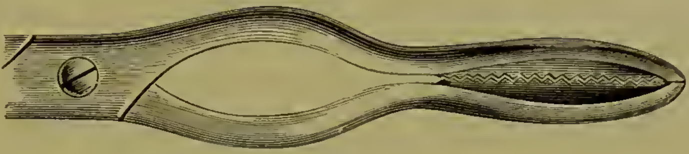
Fig. 12.

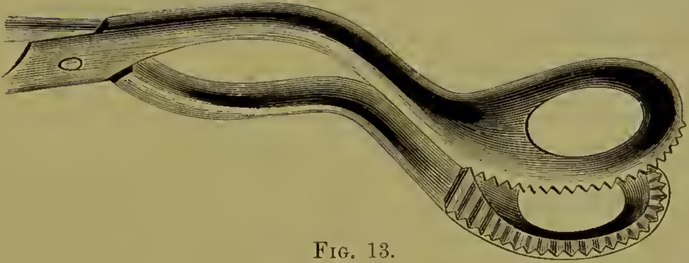
Fig. 13.

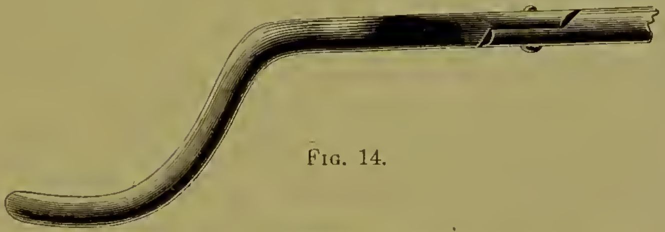
Fig. 14.

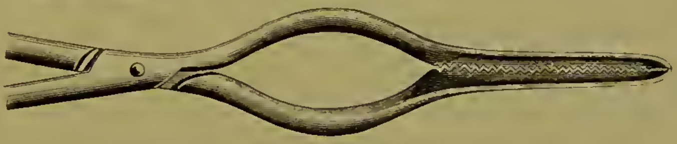
Fig. 15.

Figs. 11 to 15, from Thompson.

A pair of each pattern should have cutting edges for exceptional cases when, for example, the growth is more firm and solid than usual. When the blades are free in the cavity, they have merely to be opened easily and widely, and on closing them it is almost certain that they will grasp the polypus more or less completely. The proceeding thus advised is more likely to prove successful in accomplishing its object than is the attempt to seize a stone in the bladder. But here let it be observed that no suprapubic pressure should be made during this act; nothing should be done to interfere with the natural contour of the bladder. The operator, by light and easy movements of the forceps in varied directions, ascertains that he has the growth within their grasp. My advice is that, above all things, he is not now to pull forcibly, but that he is to press firmly the blades together, biting or chewing a little, if I may use the terms, with the extremities of the blades, without changing the original situation of the bite or grasp. Then a little twisting movement may help to disengage the mass, which, if accomplished, the forceps will be felt to be free, and may be withdrawn with their contents; after which the finger enters to feel what remains, and what more must be done in order to complete the removal. Let me remark, whenever the forceps has removed a portion, however small, the instrument should never be reintroduced until the finger has again examined the interior, and enabled the operator to form a fresh estimate of the portion remaining, if any, to be removed. But, supposing that the tumor has not been separated by the moderate amount of forceps action described, the operator may disengage and remove them; when on introducing the finger he will probably find the part so nearly severed that the actual division may be completed with the finger-nail. There is really no difficulty, nor is there any risk, with ordinary care, in removing a growth or two of pedunculated form, sufficiently near to the walls of the bladder to render the operation a permanently successful one. I suppose that the ultimate result of dividing the pedicle of a tumor in the manner described is such a cicatrization of the wound as to prevent the recurrence of outgrowth from that spot hereafter. (The different forms of forceps are shown, Figs. 11–15.)

"Other means may be used according to the judgment of the surgeon. A very small *écraseur*, with violin-string ligature, may be manipulated by the side of the index-finger, and used in polypoid forms of tumors. In the cases of women, such a tumor may sometimes be slowly and carefully brought into view by traction on the forceps, and then the pedicle may be ligatured. I have succeeded in doing this in one case; so has Mr. Bryant.

"In another I drew a polypoid mass within view, and found it was a completely encysted calculus; I then opened the mass, when the calculus escaped.

"In the male it has occasionally happened that the tumor can be drawn through the wound, as happened with Mr. Davies Colley, and also with Mr. Morris, in whose case the growth seemed to have been extruded by natural vesical efforts on the day after operation (having been left untouched on the first), and was then removed, the patient making a good recovery.

"When the growth takes a more complex form—as when several lobes spring from a wider base, the forceps must be depended upon for removing them by repetitions of the same process which is employed for the single growth. But when the base is wider still and the growth is less prominent, it is doubtful whether complete extirpation is possible by any proceeding, either through a perineal or through a suprapubic opening. The wide base involves such intimate continuity of tissue between the coats of the bladder and the structures of the growth, that I believe separation to be mostly impossible; and that ablation of the prominent portions of the growth, when feasible, should be undertaken only with the view of retarding its progress, but with no prospect of affecting complete separation of the disease from the body.

"These portions are to be seized and destroyed, partly by removal, on the plan just described, and partly by crushing, and thus inducing sphacelus and sloughing of the growth. The question of applying some chemical astringent arises in such cases, and its utility may be regarded perhaps as twofold. A solution of the perchloride of iron may tend to check the hæmorrhage, which is almost invariably very free for a few hours after the removal of wide-based growths, and it may partially destroy the portion which remains after the forceps have done their work. For this purpose I have contrived a straight and also a curved glass syringe containing a small sponge, saturated with the solution; the sponge being pressed by the piston permits the escape through small perforations at the extremity of from 30 to 60 minims of the solution, at the precise spot where it is desired to make the application.

"There is one circumstance important to be noted, especially in dealing with the less prominent growths; and that is, the effect of strong suprapubic pressure made by an assistant in relation to their apparent situation, and their mode of presentation to the finger of the operator engaged in exploring the bladder, and in estimating their size and form. If that pressure is considerable, it forces the upper wall of the bladder into its own cavity, and thus gives to the growths a larger contour than they possess, and makes them apparently salient to a much greater extent than they really are. Thus an eager or inexperienced operator, unaware of the effect of strong suprapubic pressure, might be led to seize the mass offered to the forceps, through the influence of this pressure, and, under the belief that it was a large growth, he might inflict a fatal wound by crushing a double fold of the coats of the bladder, and so making an opening into the peritonæum. To avoid such a catastrophe, it is only necessary, first, to decline the attempt to destroy any growth which is clearly not sufficiently salient to admit of complete or nearly complete removal; and, secondly, never to employ the forceps while forcible suprapubic pressure is made—at least, no more pressure than is desirable just to steady and support the bladder and the parts adjacent."

**The Suprapubic Operation.**—The revival of suprapubic cystotomy since 1880, owing to the introduction of the Garson-Petersen technique, and the application to the operation of the antiseptic regimen, and the successful modifications and improvements that have followed from time to time, have made it one of the most useful of the surgical operations of to-day, and its greatest benefits are to be found in connection with the removal of bladder tumors.

The suprapubic operation properly had its origin in the hands of Pierre Franco, who performed it with success in Lausanne about 1560. Franco in this case rendered the extraction of the stone more easy by pushing it upward by two fingers in the rectum. The case of Jean Doot, of Amsterdam, may be quoted among the early operations as a matter of curiosity, he having removed a stone from his own bladder through an incision above the pubes, made with a shoemaker's knife.

In 1581 Rousset recommended the injection of the bladder with water, with a view to elevating it above the symphysis, previous to incising it. Piètre, in 1635, tried to accomplish the same result by the introduction of a sound into the bladder.

The operation was not much heard of until Douglas and Cheselden, in England, almost a century later, revived it, both practicing it successfully several times. It now was frequently performed, meeting with varying success and failure, until it came into the hands of Frère Côme, who in 1799 had operated one hundred times, with only nineteen deaths. Perineal section was practiced in combination with the high cut by Côme and by Sermes before him.

In our century many surgeons have done the operation, among them Dupuytren, Souberbielle, Sir Everard Home, Leroy d'Etiolles, Nelaton, Civiale, etc., but it may be said that throughout this time, until of recent years, the operation steadily lost ground.

Up to 1880 but little change was made in the technique. Since then three notable advances have again placed it in the category of favorite surgical operations; these steps are: (1) Antiseptics; (2) vesical suture or drainage; (3) vesical injection combined with the use of the rectal balloon.

**Rectal Balloon.**—In 1880, at Copenhagen, Petersen described his method of raising the bladder and with it the peritoneal fold by means of an oval-shaped rectal balloon. (Garson had previously demonstrated the same possibilities on the cadaver.)

The process consists, after the patient is prepared in the usual way for operation, in passing a catheter into the bladder through which about ten ounces of a four-per-cent boracic-acid solution is injected, the rubber balloon greased with vaseline folded upon itself longitudinally, having been previously introduced by an assistant into the rectum, so that its outer end is securely placed above the sphincter. Ten ounces of warm water are then injected into the balloon (some operators prefer to make the preliminary incisions through the abdominal muscles previous to inflating the balloon, and this is the author's own preference, the object being to reduce the period of rectal distention to as short a time as possible). By this manœuvre the peritoneal fold at its attachment to the anterior surface of the bladder is raised from two to four fingers' breadth above the symphysis pubis, and thereby is avoided one of the principal dangers, as already pointed out, of the operation—namely, the wounding of the peritonæum. In a few cases the peritonæum will have an abnormally lower attachment, and will not be raised sufficiently above the symphysis pubis under these circumstances.

In a few others, owing to previous inflammatory processes, the peritonæum may be found to be attached to or about the symphysis pubis. In such cases it must necessarily be wounded before entering the bladder.

In still another class of cases, chiefly those in which a long-standing cystitis has been associated with prostatic hypertrophy, resulting in great thickening and rigidity of the bladder, the bladder will be found to have lost its elasticity, and be incapable of sufficient distention to allow of its being elevated above the symphysis pubis. With these exceptions the bladder will rise, as already described, when Petersen's method is used.

Various experiments, notably those of Garson, of Fehleisen, and recently of Dr. A. B. Strong, of Chicago, with reference to the degree of elevation of the bladder by the use of the rectal balloon in conjunction with the injection of varying quantities of fluids of different kinds and of air into the bladder, have established the fact of its more or less successful accomplishment in the large majority of instances, and given it a valuable position in the eyes of many surgeons.

Dr. Strong's conclusions, derived from his anatomical study of the subject, are as follows :

"1. In the normal condition, the bladder and rectum being empty, the apex of the bladder and peritoneal reflection are a little above the arch of the pubes.

"2. In moderate distention of the bladder, the anterior peritoneal reflection is below the arch ; with the same degree of distention and the bladder pressed against the abdominal wall, the peritonæum ascends higher.

"3. Suprapubic cystotomy can be most easily and safely performed when the bladder is lifted from the pelvic floor and moderately distended against the abdominal wall.

"4. Distention of the rectum alone elevates the base of the empty bladder, but does not raise materially the vesico-abdominal fold of peritonæum.

"5. Distention of the bladder alone, in thin subjects particularly, requires relatively a greater amount of fluid to elevate the peritoneal reflection. The bladder is not crowded against the abdominal wall, but rather falls away from it.

"6. Moderate distention of both rectum and bladder meets the indication the best; from ten to twelve ounces in the rectal bag, and eight to ten in the bladder, is generally enough, and seems to be a safe quantity to use.

"7. Dilatation of the rectum first and the bladder afterward lifts the peritoneal reflection the highest.

"8. The object of the rectal bag is to elevate the distended bladder and press it against the abdominal wall and so crowd up the peritonæum.

"9. To meet the indication, the gut should be dilated from the anus to near the promontory of the sacrum.

"10. The rectal bag should be sausage-shaped, of rather thin rubber, rather than pyriform and thick, for the thinness enables it to follow up the gut, and the shape makes uniform pressure throughout the entire length.

"11. In a very fleshy subject, with a flabby or pendulous belly, the bladder is relatively freely movable. In such a case it will easily rise out of the pelvis against the abdominal wall, when alone distended with a moderate quantity of water; the rectal bag may then be safely dispensed with.

"12. Air injected into the bladder of a subject lifts the bladder and its peritoneal reflection out of the pelvis better than water.

"13. In one case the gut was ruptured opposite the promontory of the sacrum with twenty-three ounces in the rectal bag; in no case was the bladder ruptured.

"14. In the cases reported an average of fourteen ounces in the rectal bag and twelve in the bladder elevated the anterior peritoneal reflection an average of one inch and a half above the crest of the pubes; the apex of the bladder was one inch higher."

In twenty-five experiments reported by Dr. Helmuth, when the bladder alone was injected with twenty-seven ounces of water, the peritoneum was lifted two inches and the apex of the bladder four inches above the crest of the pubes. In five cases rupture of the bladder occurred with an injection of fifty-nine fluid ounces.

Of recent years there has been a tendency on the part of various surgeons to omit the use of the rectal balloon, and to operate without it, in the ordinary position of the patient, or to adopt the postural method of raising the bladder introduced and practiced by Trendelenburg, who omits the rectal balloon entirely, and seeks to secure the elevation of the bladder by raising the legs and pelvis of the patient. When this is done, Trendelenburg says that, the intestines and diaphragm falling toward the thorax, draw the bladder after them out of the pelvis, and that the latter organ and its anterior peritoneal fold are in this way as satisfactorily raised as by means of the rectal balloon; and that the additional advantage is offered in that the bladder maintains its elevated position after it is opened, and is thus rendered easier of access for instrumental manipulations in its interior.

Trendelenburg has devised a special form of operating chair, by which the inverted posture of the patient is secured. In its absence the same end may be attained by placing cushions beneath the pelvis, and having the legs raised by assistants. The objections to Trendelenburg's method are the necessity of possessing the special operating chair, or, in its absence, of being obliged to maintain the awkward position of the patient at the cost of considerable labor, but more especially, so far as the author's experience goes, the elevation of the bladder is far less satisfactory than that secured by Petersen's method. (Trendelenburg's chair is shown in Fig. 16).

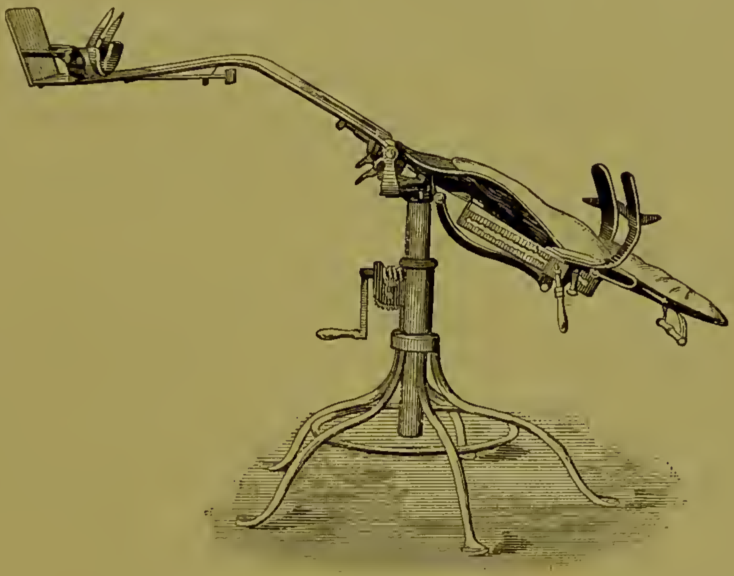

FIG. 16.—Trendelenburg's operating-chair.

In the author's experience, the rectal balloon is of the greatest assistance and value in elevating the bladder and its peritoneal fold, and pushing the whole organ forward against the abdominal wall, and making it much more accessible.

The dangers attending the use of Petersen's method, that have been dwelt upon, are rupture of the bladder and rupture of the rectum. Examples of such occurrences are noted in the Annals of Surgery, vol. xii, 1890, page 129, by Dr. Fowler, of Brooklyn, who publishes an instance of this accident occurring in his own practice. This happened in a man sixty-three years of age, who was the subject of an hypertrophied prostate. The rectal colpeurynter and the bladder were each injected with eight ounces of fluid. The rectum was ruptured in this case, a rent of four inches having occurred upon its upper wall. The autopsy showed that the rectal wall was unusually thin and weak. The author then quotes the following cases :

That of Cadge, reported in 1886 (Proc. Roy. Med. and Chir. Soc'y, London, page 97, 1886), in which the rectum was ruptured by a colpeurynter containing eighteen ounces of fluid.

Nicaise, in 1888. A rupture of the rectum, the rectal bag being filled with ten and a half ounces, and the bladder with eight and a half ounces of fluid. This accident happened in a man sixty-five years of age.

In old people, with trabeculated bladders, there are occasionally found diverticula with very thin outer walls, which moderate distention of the bladder would be quite sufficient to rupture. It is impossible to have a knowledge of the existence of this condition beforehand, and, as it is rare, the surgeon may justifiably take the risk of its being present in any given case. In adults the danger of rupture of the rectum will be practically never incurred, if the quantity of fluid injected into the balloon and bladder is limited to ten counces in each, and this is almost always sufficient to raise the bladder satisfactorily.

If, during the injection of either the bladder or rectal balloon, great resistance is experienced, it should be taken as an indication to cease at once from the attempt to force in any more fluid, and the operation should be proceeded with as well as may be under the conditions. Such resistance will be encountered in cases in which there is a small bladder with thickened, rigid walls, such as are seen in certain patients, as the result of chronic cystitis, or hypertrophy of the prostate, and will be also noticed in the rarer condition of extreme bladder irritability, which sometimes persists even during the anæsthesia of ether, the organ contracting violently after a few ounces have been injected into it.

In a few cases, failure to elevate the peritoneal fold occurs, owing to its adherence, from previous inflammatory action, to or about the symphysis pubis. But the above conditions are relatively rare, and Petersen's method is applicable and innocuous in the vast majority of cases.

In children, three ounces of fluid in the bladder and three in the rectal balloon will be ordinarily free from risk, and sufficient.

The abdominal incisions are next made in the following way: The incision is begun in the median line about three or four inches above the symphysis pubis (in fat subjects the incision should be longer, in lean ones shorter), and is carried down to and a little over the upper margin of the symphysis pubis. The fascia covering the recti muscles is next divided, and the incision carried, if possible, through the linea alba down to the prevesical space. This is at once recognized by the presence within it of more or less yellow fat. Immediately beneath this lies the bladder. At this point of the operation there are two methods of procedure advised. Most operators counsel the lifting up, toward the upper angle of the wound, of the presenting fat, with the index-finger, until the bladder is exposed to view. The object of this manœuvre is to carry upward with the finger, together with the fat, the peritoneal fold which may lie within it.

The objection to doing this lies in the disturbance of the contents of the prevesical space, for, in some instances, especially where there is a good deal of fat, holes and pockets may be made by pulling up the fat as described, which will give lodgment subsequently to the fluid draining from the bladder, and incur the risk, which is one of the most serious ones, as already mentioned, of originating in these spaces, septic phlegmon and subsequent pus-burrowing. It is a rule that can not be too strongly adhered to that *there should be as little disturbance as possible of the anatomical relations of the tissues lying in and about the prevesical space*, during the operation.

This can be better secured by dividing cautiously the fat-layer with blunt-pointed scissors, until the bladder is laid bare. The peritoneal fold, should it be placed low, and encountered in the course of this division, can be recognized and avoided by lifting it upward out of the way. In either case the bladder when reached is easily recognized as a dense, rounded body bulging upward, of a dark-red or purple color, bearing on its surface a number of veins; its appearance is oftened likened to that of the head of the fœtus presenting at the vulva. The author has never encountered bleeding of any importance, in exposing or opening the bladder.

The usual step now is to insert a tenaculum as high up upon the presenting surface of the bladder as the position of the peritoneal fold will allow without injuring it. This instrument in the hands of the assistant serves to maintain the bladder in its high position after it is opened. As soon as the tenaculum is placed, the bladder is opened by one clean incision, extending from immediately below the tenaculum downward for an inch or an inch and a half in length. The fluid contents of the bladder now immediately rushes out through the wound. As soon as possible sutures should be placed about the middle of either edge of the bladder incision, in order to separate its edges and to sustain it and prevent its falling downward behind the symphysis pubis. The rectal balloon is now emptied, and spatulæ or wire *écarteurs* are inserted within the bladder to open its cavity to view and to expose the growth. For this purpose two or more single-bladed Sims specula may be used, which are employed by Bazy, in France, but strong wire instruments which can be bent to any desired form are preferable. There is almost always a tendency of the summit of the bladder to bulge downward and obscure the cavity of the organ. The most important speculum, therefore, is that which is placed in the upper angle of the wound, to obviate this difficulty. There should be as little manipulation as possible within the bladder at this time; otherwise, bleeding may be excited from the growth, and so obscure the view. When the bladder is emptied of its contents, the cystoscope-tube of Leiter or any other convenient electric lamp may be introduced within the bladder from above through the wounds. Eigenbrodt has proposed (Archiv für klinische Chirurgie, 1889) a special form of speculum and electric lamp combined to answer this purpose.

The author has not personally used this instrument, but from its description it seems too complicated and too little adapted to its purpose to be of especial value. It has the great disadvantage of an exposed lamp, which is readily broken by contact with fluid. The author's own method of exposing the bladder and the advantages which he has found it to afford over and above those offered by the other methods in use were described at the Berlin Congress in August, 1890, and published as follows, in the London Lancet, October 18, 1890, under the title of—

*A New Means to assist in the Removal of Intra-vesical Growths through a Suprapubic Cystotomy.* In spite of the various improvements that have been applied to suprapubic cystotomy since its revival in 1880, which have brought its technique so nearly to perfection, I have thought that a still further advance might be made in regard to some of its steps, when the operation is undertaken for the removal of intra-vesical tumors or prostatic hypertrophies. The steps of the operation which I have sought to improve are those which relate to the exposure of the interior of the bladder after it has been opened, and to the removal of the growths. I was led to make these modifications by the objections experienced in the use of the methods at present employed. With reference to the exposure of the interior of the bladder, the method of Trendelenberg seems to me cumbersome and awkward. The use of tenacula, or threads, or spatulæ, to sustain and open the bladder to view, calls for a number of assistants' hands, which are in the operator's way. The assistants frequently displace the spatulæ or écarteurs, and let them assume faulty positions. Furthermore, solid-bladed écarteurs like those used by Bazy, cover up a portion of the bladder wall and interfere with the view of the growth and its removal by instruments. To obviate these difficulties I have devised a bladder speculum (Figs. 17 and 18) which seeks to accomplish, by one instrument, all the objects, both for sustaining the bladder and exposing its interior to view, now gained by tenacula, threads, sutures, écarteurs, or posture of the patient, while doing away with the objections to the use of the latter methods, enumerated above.

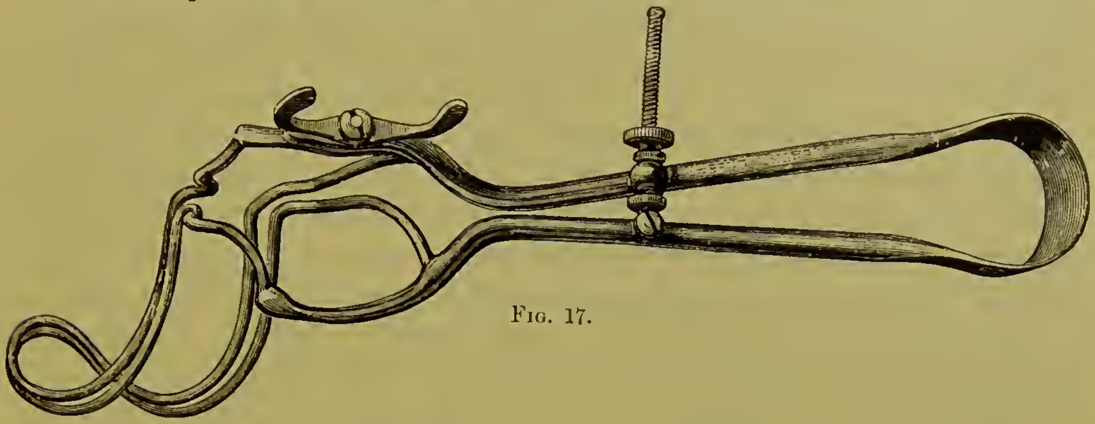

Fig. 17.

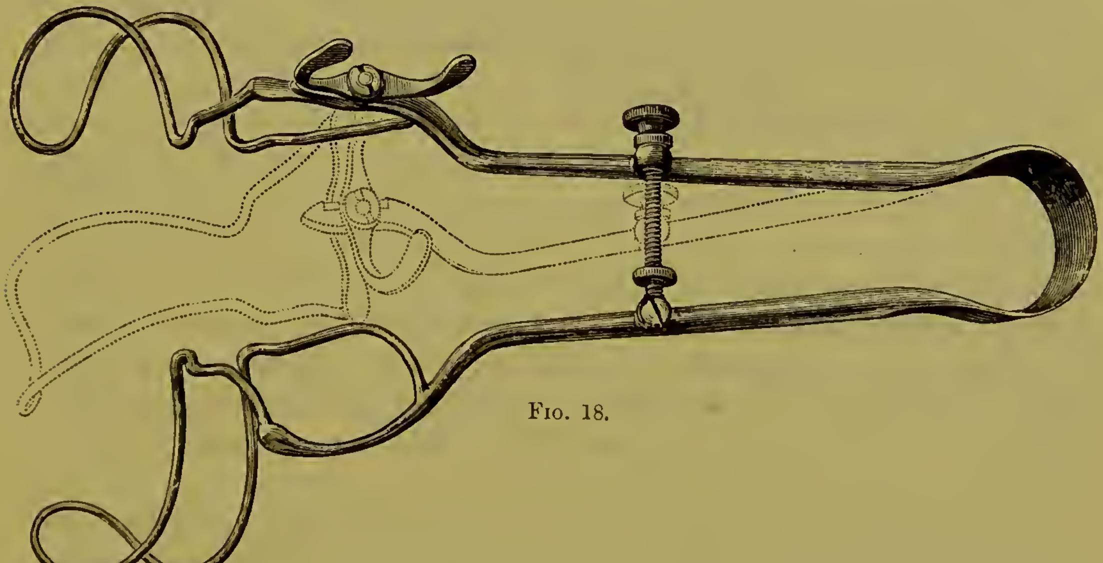

Fig. 18.

Figs. 17 and 18.—Author's bladder speculum, for exposing the interior of the organ after suprapubic cystotomy.

The speculum consists of two strong wire blades, which, when closed, as in Fig. 17, can be readily introduced into the bladder through an incision of one inch or a little more in length. Above, the wire blades are attached to either side of a stout steel shaft or handle which terminates at its farther end in a strong spring, the action of which is to separate the two sides of the shaft, and consequently, also, the wire blades of the speculum attached to either of them. About the middle of the shaft, and connecting its two sides, is a screw by which their separation can be controlled by governing the action of the spring. The blades of the instrument are introduced closed (as in Fig. 17) into the bladder. The speculum is then opened (as in Fig. 18) by rotating the inner blade upon a pivot by the thumb and one finger; this blade then assumes a position opposite to its fellow, at the same time moderately distending the cavity of the bladder. The sides of the abdominal and bladder incisions can now be still further separated, and the bladder at the same time further distended by turning the screw outward along its thread, thus allowing the spring to push the handles apart. The instrument then takes the position shown in Fig. 18, and between its blades a free view of the field of operation is obtained. To withdraw the speculum, its blade is rotated back again and the sides of the shaft approximated by the screw; the position is then again as in Fig. 17, and it can be easily withdrawn. With the blades opened, the inner surface of the bladder incision rests upon the shoulder formed by the angle at the junction of the upper and lower portions of each wire blade. The bladder consequently can not collapse or fall downward behind the pubes, but is held close up to the abdominal wound, and firmly fixed in that position, even when no hand holds the handle of the instrument at all. This does away with the necessity of having two or more hands to sustain the bladder with tenacula, or threads, and dispenses with sutures also, which require time to place, and may tear out under strain. By grasping the shaft of the instrument with one hand the operator can raise or lower the bladder at will, and by turning the handle from side to side can expose to view and operative manipulation all parts of the interior of the organ. In using the speculum the bladder should be sustained by a tenaculum below the peritoneal fold while it is incised, and until the speculum is introduced and its blades opened. The tenaculum is then withdrawn. The open, widely fenestrated wire blades allow the best view; do not cover up portions of the surface against which they rest, and give room between their sides for the passage of instruments.

To recapitulate. The advantages gained by this speculum are: The placing of the bladder for all purposes of sight and instrumental manipulation under the control of the single hand of the operator, and the doing away with the objections to the other methods already mentioned. The contrivance is simple, inexpensive, easily cleaned, and efficient; it saves time, and facilitates decidedly the removal of bladder growths. In order to allow for the differences in the capacities of different bladders, and also for the varying thickness of the abdominal wall in different individuals, the speculum is made in three sizes; the medium and smaller sizes will be found, I think, generally sufficient. There are, on the other hand, certain limitations to the use of this speculum, to which special attention should be given, else one may be disappointed in the instrument. It will be found inapplicable should the growth be an unusually large one, with a salient, firm base, because in that case the rotation of the inner blade may become impossible, and the instrument, therefore, can not be opened. The same is true if there be a very small, contracted, inelastic bladder, for the same reason. If the patient be not completely anæsthetized, the blades can not be opened, owing to their being held together by the recti muscles in contraction. Once opened, however, the blades can be locked in that position by the screw-head on the inner side of the handle. The second step relates to a device for the removal of the growths, and is based on the assumption that, when practicable, it is desirable to effect their removal by galvano-cautery action. The instrument shown in Fig. 19 is designed as a more convenient and more easily applied form of cautery than we have at present.

It has the form of a short, right-angled-bladed pair of scissors, the curves of which are such that the burning surface, which is a platinum wire lying in the center of one of the blades, can be applied easily to a growth in whatever part of the bladder it may be situated. This is its principal advantage. The wire is insulated by a bit of slate of triangular form, upon the apex or inner surface of which it lies; the opposite blade is similarly furnished with another piece of slate. The triangular form of these bits of slate serves to protect the bladder wall from injury by the heated wire by holding it away from the mucous membrane by about one eighth of an inch. The cautery can be passed between the blades of the speculum or through their sides, and the growth seized and burned off; as an extra precaution against burning the bladder wall, it is well to interrupt the current frequently, especially if dealing with a tough-based growth, which requires some time to burn through. If the growth be too large to be burned off by one application of the cautery scissors, it can be removed piecemeal by successive applications. This instrument also has its limitation. It can not be successfully applied to very broad-based, sessile growths, but with this exception it will, I think, be found most useful. The bladder may, of course, be illuminated in using these instruments, as is now usually done, by the electric cystoscope lamp, introduced through the suprapubic incisions or through the urethra. I have

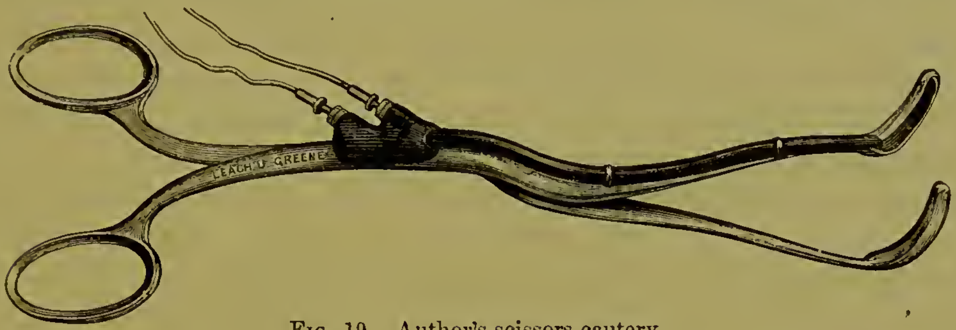

FIG. 19.—Author's scissors cautery.

used these instruments in four cases—two of bladder tumors and in two prostatectomies. These patients all made a good recovery from the operation, the performance of which was greatly facilitated by these new devices. (The instruments can be obtained of Leach & Greene, Tremont Street, Boston, Mass., U. S. A.; or of Krohne & Sesemann, 7 Duke Street, Manchester Square, London.)

The choice of instruments for the removal of the growth must depend on the nature of the latter, its position, etc. If markedly pedunculated, the pedicle may be caught with forceps, such as those used by Sir Henry Thompson in the perineal operation, or encircled by the wire or galvano-cautery wire snare, or by the author's cautery scissors just described, or divided by scissors. If sessile, it is best removed by the curette, or if of delicate structure, by the finger-nail. The base, unless the removal has been made by a cautery, should be touched lightly with the paquelin cautery, which serves the double purpose of checking hæmorrhage and of destroying the growth more thoroughly. If scissors, forceps, or snare be used, care should be taken not to include the bladder wall beyond the base of the growth in their application; otherwise there is danger of perforating it. The growth, however, should be removed down to the level of the surrounding mucous membrane at least. Another advantage in using the paquelin cautery for treatment of the base of the growth is that it gives a very good illumination of the interior of the bladder. In cases of large, dense growths it will be sometimes necessary to remove them piecemeal. Thorough exploration should always be made by sight and by touch of the whole interior surface of the bladder, in order that no small beginning growths may escape detection which may readily occur when they are multiple. Hæmorrhage, as a rule, is not a serious complication in these operations. Occasionally in a growth with a large, dense base, one or more arterial vsssels of considerable size may be severed and may sometimes be successfully ligated. The best means, however, as a rule, for checking bleeding is by application of the cautery as already mentioned. In case of a free and persistent oozing of blood from the seat of removal of an extensive sessile growth, it is best to pack the interior of the bladder, for a few hours at any rate, with iodoform or sterilized gauze. As a rule, more or less oozing of blood will take place from a site of operation for from one to four or five days, and in exceptional cases for a longer period.

A modification of the bladder incision has been proposed by Antal, of Buda-Pesth, by making a cross cut instead of the perpendicular one, and by dividing the bladder, layer by layer, by successive incisions. One of the advantages claimed for this incision is that in cases in which the peritoneal fold is low it may be avoided, while still obtaining ample room through the wound in which to work. This is of distinct value in cases in which the peritoneal fold is found to be low. The wound, however, ordinarily does not give any more room in which to work than the perpendicular cut, especially if the latter be increased, as it may be without harm, by the slight lateral incision at its middle point on either side of the edge.

The after-treatment of the wound is a matter of importance. There are three methods in vogue: immediate suture of the entire wound, with the intention of securing prompt union; partial suture of the bladder wound, with drainage; and the absolutely open method, with drainage. Among those who have used the suture with success are Ultzmann, Parker, Zezas, Antal, Kummel, Orlowsky, Makawejar, Zancarol, Julliard, Reverdin, Kispert, Von Bergmann, Bassini, Koenig, Corradi, Petersen, Miekuliez, Pilehar, Dulles, Lister, Keyes, Lindrier, Lucas Championnière, Pean, Schwartz, Pozzi, Tuffier, Marcsee, Guiard.

As a rule, French surgeons are in favor of the open treatment of the wound, or of partial suture with drainage, as are also Sir Henry Thompson, Dittel, Meyer, and Trendelenberg. In the open method the upper and lower angles of the outer wound only are sutured, the bladder wound left entirely open, and the double-siphon drainage-tubes as used by Perier (Perier employs two large rubber drainage-tubes which he inserts down to the lowest part of the bladder; they lie side by side, and should have, beside the open ends, another hole cut in the bladder extremity of each just above its end) are inserted into the bladder, attached to the margin of the outer wound and led through the antiseptic dressing to a receptacle placed within the bed or on the floor beneath it. In using these tubes the author prefers to cut them off immediately above the antiseptic dressing, and to insert into each a short bit of glass tubing, attaching to the outer ends of the glass tubes long rubber tubes which go to the receptacle. This has the advantage of enabling one to judge more readily at what point in the course of the tubes any stoppage has taken place, should such occur by coagula, and, also (by detaching the glass tubes at the points at which they join the rubber drains leading into the bladder), of securing a shorter circuit for fluids used in subsequent washings of the bladder through them. These washings should be employed daily, as a rule, during at any rate the first few days after the operation; and if there is evidence of cystitis or much *débris* within the bladder, they should be continued. The better washes to employ under these circumstances are the milder antiseptics, such as a four-per-cent solution of boracic acid and a solution of permanganate of potash of the strength of 1 to 3,000 or 4,000.

If the tubes perform their work properly, as in the author's experience they have invariably done, they act as complete siphons, and the fluids of the bladder flow through them completely, keeping the patient entirely dry. After the fifth or sixth day the author has found it advantageous to replace the larger drains by two of smaller caliber, and, unless bleeding still persists, or cystitis is present, at the end of the eighth or ninth day to remove one of the tubes, taking out the remaining one from the tenth to the fourteenth day, according to circumstances.

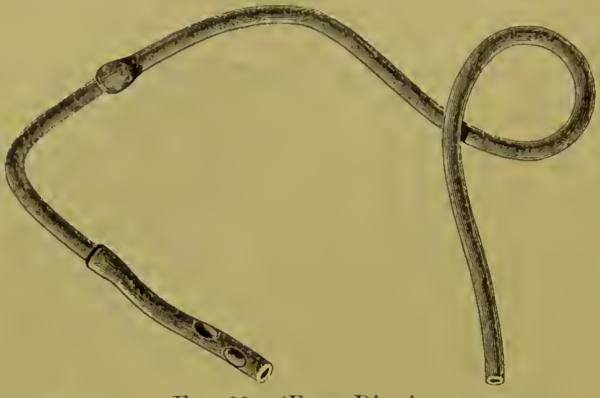

Fig. 20.—(From Dittel.)

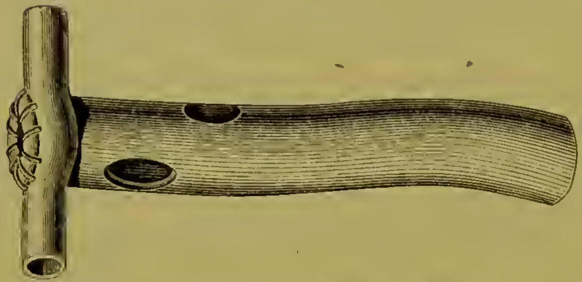

Fig. 21.—Trendelenburg's suprapubic drain.

Dittel has made a modification of the drainage-tube, and employs one of hard rubber, which is bent upon itself above the symphysis pubis in such a way that its outer portion points downward between the thighs.

Trendelenburg employs a T-shaped tube. Both of the above are illustrated in the accompanying cuts.

At a meeting of the New York Academy of Medicine, January 12, 1891 (Medical Record, March 7, 1891), Dr. Willey Meyer describes a form of drainage-tube used by him after a suprapubic prostatectomy. This consists of a soft-rubber tube led through a hard-rubber shield, by which it is secured in place. Dr. L. B. Bangs, in the same meeting, also described a drainage-tube of similar pattern.

The advantages of the open method and drainage are: (1) Avoidance of the danger of urinary infiltration into and about the prevesical space; (2) the shorter time required for the completion of the operation as compared with that when vesical suture is applied; (3) the beneficial effect of drainage and rest to the bladder where cystitis is present; (4) the hæmostatic effect of leaving the wounds open.

The one disadvantage of the open treatment which is urged against it by advocates of the closure of the wounds by suture is that of prolongation of convalescence. It is generally agreed that this is true, and that the time before complete healing occurs, when the wound is left open, is increased on an average about ten days as compared with that of the closure of the wound when successful. The average length of time required for healing of the wounds when they have been left open is from twenty-one to thirty days.

A compromise between total suture and the open method has been often practiced in partial suture of the bladder wound, closing it so far as to leave room only for the passage of the drainage-tubes. Examination of the results in point of time and in point of success of this method as compared with the entirely open method, leaves but little to choose between them.

In an original memoir in the Annales des Malad. des Org. Gen. Urin., October, 1890, M. de Dellefosse presents in a very admirable manner the subject of bladder suture as compared with the open methods of treatment. The following is a summary of his remarks:

"In 1883 Dr. Bouley published a statistical report of twenty-three cases of vesical suture after suprapubic cystotomy. In this series of cases failure to unite occurred in ten; silk phéniqué was used eight times, with three failures; catgut was used eleven times, with seven failures; silver wire twice, with no failures; and ordinary silk twice, with no failures. In the cases of failure it was generally upon the sixth day that leakage began."

In 1884 Terrillon published twenty-five cases of suture of bladder wounds which had been made accidentally for ovariotomy. There were fourteen deaths in this series, but in the large majority they were wholly independent of the bladder injury.

Bladder wounds in this class of cases offer the most favorable conditions for the success of the suture, for the bladders are generally healthy, and the wounds are within their peritoneal surfaces, the healing of which by rapid agglutination is far more likely to occur than when the wound lies without the limits of the peritoneal covering.

In 1884 Truffier published a collection of one hundred and twenty cases of suprapubic cystotomy undertaken for various purposes between the years 1879 and 1883. There were of these twenty-two cases of stone in which the suture was applied to close the bladder wound. Among these were only two successes. In the failures, leakage occurred from the first to the ninth day. In one of the two successful cases, interrupted catgut sutures were used; in the other, silk phéniqué. In these two cases the wounds healed finally on the thirtieth day. In sixteen of the failures, three serious accidents can be attributed to the suture.

In 1884 Garcin reported seven cases of suture of the bladder of Boeckel, of which five died of urinary infiltration. In the same year Malharb Webber reported forty-one cases of suprapubic lithotomy and suture, with sixteen successes. There were eight deaths; seven were septic, and one was from erysipelas.

In 1886 Dr. Gross, of Nancy, reported forty cases of vesical suture after suprapubic cystotomy; of these only two died, 5 per cent as compared with the mortality of the operation, which he states to be 21 per cent, from which he concludes that the suture is less dangerous than it has been supposed. In fifteen cases of complete suture there were five unions by first intention, and ten failures, but no accidents. Complete suture of both bladder and abdominal wounds gave the best results, namely, nine cases with four complete successes. Since 1887 the showing has been more decidedly in favor of the suture. In children the results of the suture are especially good.

Dietz, 1890, reports forty-seven cases of suture collected since 1880, with the following results: Two deaths, fourteen failures of union by first intention, thirty-one cases of union by first intention; average duration of treatment seventeen days in the successful cases, twenty-six days in the failures. It is to be remarked that from eleven cases in this series in children all were successful. Dellefosse goes on to say that there are certain conditions in which the majority of surgeons agree that the suture should not be applied. These are, first, in cases of tumors; second, in cases of chronic cystitis with vesical changes; third, in tuberculous cystitis; fourth, in cases where there is a tendency to phosphatic deposit. The advantages of the suture would be certain if, first, it can be shown that with it cicatrization is much more rapid; second, that the cicatrix is more firm; third, that it renders the wound more septic; and, fourth, that is is without danger. In regard to the first, the advocates of the complete suture claim that, when successful union occurs about the fifth day, yet, nevertheless, the duration of the after-treatment of the wound is seen to continue from eighteen to twenty-six days, and these statements are based upon the results of the most favorable cases. At best there are only about 60 per cent of recoveries after the operation in all classes of cases when the suture has been applied. This is certainly no better than when the wounds have been left open. With the latter method there is the great safeguard that the urine escaping either through or around the tubes does not infiltrate, while with the suture, especially if the outer wound be closed, the condition is one that favors infiltration, by which a distinct danger is thus encountered.

Dellefosse's conclusions are, first, that the vesical suture ought to be rejected in more than two-thirds of all cases of suprapubic cystotomy; secondly, it is only actually indicated in the cases of intra-perineal wounds, and then only when the bladder and kidneys are thought to be normal; thirdly, the partial suture with siphon drainage gives quite as good results.

In the Dictionnaire Encyclopédique, Hache makes the following comments: "What does one gain by suture? If successful, the duration of convalescence is shortened by perhaps ten days; but this advantage is secured at the price of a decided prolongation of the anæsthesia, and especially at the risk of urinary infiltration subsequently."

The author's belief in regard to the application of the vesical suture is that until it has been so far perfected as to secure union by first intention, with very few exceptions, it should not be employed for the purpose of total closure of bladder wounds except, of course, in cases of traumatism, or accidental injury during operations upon abdominal tumors, and perhaps in children in whom it is attended with much more success. In cases where cystitis is present, it is of distinct advantage to prolong the drainage, and, moreover, success with the suture in such cases is less likely to occur. Cases of bladder tumors are least of all suited for the employment of total suture, although several entirely successful results are recorded.

In one of the author's cases, in which the bladder wound was closed after the removal of a papilloma, the vesical tenesmus which was produced by the retention of clots within the bladder decidedly increased the shock of the operation, endangered the patient's life, and produced great pain. Relief followed upon the removal of one or two of the stitches, but convalescence was prolonged by the foregoing accidents. If the vesical suture is to be used, that form should be selected which, while it effectually closes the wound, is at the same time capable of being rapidly applied. For this purpose the suture of Brenner, which is in the form of a double purse-string, as indicated in the accompanying figure, is well suited. The application of this suture is described by Brenner thus: "The usual incision is made in the bladder; the mucous membrane is then separated from the muscular coat above it for a slight distance around the margin of the wound; a continuous silk suture (*a*), as in Fig. 22, is then passed around the wound in the submucosa. A similar suture (*b*) is previously passed around the wound in the muscular layer, the suture (*a*) is then drawn tight and tied, and the same is done with the suture (*b*)."

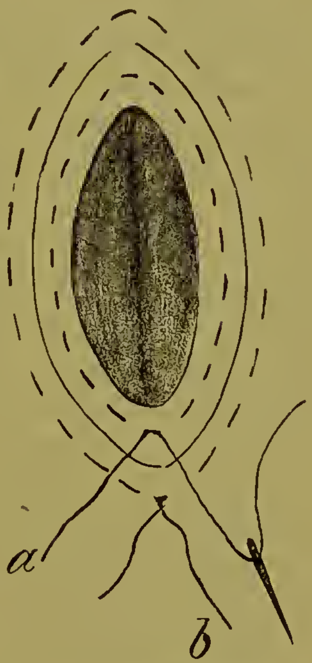

FIG. 22.—Brenner's suture.

(The author has twice recently employed this suture to close wounds made in healthy bladders during the course of an abdominal hysterectomy; the patients died on the sixth and on the fourth days respectively, there having been no symptom of bladder disturbance or of leakage in that interval. On examining the organ after death, the closure by the suture was found to be perfect, and the wound was in the process of healthy healing.)

The only objection to its use lies in the fact that it compromises a larger portion of the bladder than others. Unless, however, the wound is of large extent, this is an insufficient objection. It is very ready of application, and one of the simplest in use. The form of suture which the author prefers is the right-angled suture suggested by Dr. H. W. Cushing, of the Boston City Hospital, for the closure of intestinal wounds, which is illustrated in the following figure (23).

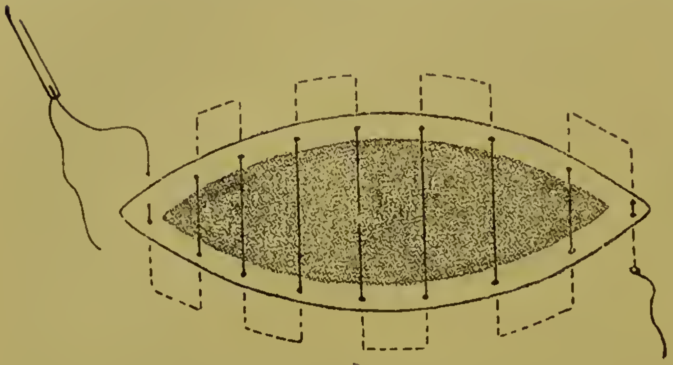

FIG. 23.—Cushing's suture.

If the complete vesical suture be applied, the abdominal wound may be left open through the greater part of its extent or wholly closed. In this connection the report of Alexandron (Arch. für klinische Chir., 41. Band, 4. Heft, 1891, page 877) should be noted. In eighteen out of twenty-six cases in which he sutured the bladder after a sectio alta, he left the lower angle of the abdominal wound open, and drained it; in none of these cases did he secure a complete union by first intention. The remaining eight he sewed all the wounds tight. In seven of these he got a complete first intention without any leakage of urine whatever. In one case the sutures were removed owing to an intravesical hæmorrhage. These cases were all in children; but so were the first series of eighteen, and it must be admitted that the uniformly better result in the second series of eight is suggestive of the desirability of further trials in the direction of total suture of all wounds; but a further experience is needed to support the same view in regard to the advisability of this plan in the varying and more difficult conditions encountered in adults; and in bladder tumors, in which connection the subject is here considered, the desirability of closure of the wound is most open to doubt.

Up to the present time it can not be said that the total suture of the abdominal wound is free from danger to life, and certainly the percentage of successes does not at the present rating exceed 70 per cent in adults in the most favorable computation. The author's experience has been so distinctly favorable to the employment of the open or partially open method of treating the bladder wound, that he is strongly prejudiced in its favor. Of five operations for the removal of benign bladder tumors treated by siphon drainage and open method, the wounds, abdominal and bladder, closed in the following periods of time:

The first, on the fifteenth day; the second, on the eighteenth day; the third, on the eighteenth day; the fourth, on the sixteenth day; the fifth, on the twenty-third day. The patients were out of bed at the end of these times.

**Helferich's Partial Resection of the Symphysis Pubis.**—In the Arch. für klinische Chirurgie, Band 73, part third, page 625, 1888, Helferich proposes in certain exceptional cases a partial resection of the symphysis pubis. He advises the performance of the operation in the following way:

A horizontal incision is made just above the upper margin of the symphysis pubis, extending laterally on either side to a point slightly beyond the tubercle of the os pubis, taking care not to wound, of course, the vasa deferentia. The soft parts are now divided down to the bone, and separated thoroughly from it. The periosteum need not be preserved except at the extremities of the exposed bone on either side. The bone is now divided to the desired depth by a chisel applied just beyond the tubercle of the os pubis on either side, taking care not to open the obturator foramen; the portion of the bone included between the two chisel-cuts is now removed by the chisel applied in a horizontal direction, or sidewise along its anterior surface. The finger is placed on the under surface of the symphysis during the chiseling, so as to guard against any injury to the bladder by the instrument. As soon as the bone is divided, the soft parts attached to the inner surface of the symphysis are drawn to either side by hooks, and the anterior surface of the bladder becomes widely exposed.

Helferich originally added a perpendicular cut to the horizontal one, making a T-shaped incision, but has subsequently decided that the cross cut alone is sufficient.

(Helferich favors the cross incision, in the ordinary suprapubic operation, in preference to the usual perpendicular cut.)

The partial resection gives a much better opportunity than the ordinary method to strip back the peritoneal covering, where this is desired (as in the extra-peritoneal method of resecting the portion of the bladder in the case of malignant growth of the apex). Helferich advocates this partial resection as described, in any case in which either the size of the stone or tumor, or low attachment of the peritoneal fold, or its adhesion from inflammatory action or a non-distensible bladder, makes a large wound desirable, or the bladder inaccessible by the usual suprapubic cut.

Helferich adds the report of two cases, in one of which he performed the above operation for disease of the bone of the symphysis, the patient making a good recovery. In the second he removed a carcinoma of the bladder, and states that the growth was much more readily dealt with than would have been the case by the ordinary incisions.

He claims that no interference of locomotion from weakening of the pelvic arch ensues from his operation.

The author has no experience of this operation, but has performed it on the cadaver, and it certainly gives freer access to the bladder, and commends itself for further trial under the special circumstances for which it was designed.

In 1888 Langenbuch proposed another route to the bladder, which he called "sectio alta subpubica." By this he proposed to expose the anterior surface of the organ by an incision between the pubic arch and the root of the penis. Langenbuch claims for this method the following advantages: (1) The opening of the bladder is at the lowest point; (2) avoidance of the peritonæum; (3) avoidance of urinary infiltration; (4) avoidance of the necessity of a catheter in the urethra for subsequent drainage, and of the need of bladder suture; (5) the possibility of union by first intention.

The incision is made in the form of an inverted Y, the vertical incision extending from the root of the penis over the symphysis, the two side-cuts right and left on either side of the penis. The penis is loosened from its attachments to the symphysis. The triangular ligament is then divided beneath the arch of the symphysis, and the urethra with its attachments is pushed backward; by this means a free space is given in which to reach and open the bladder, which is done by an incision above the plexus of Santorini.

Langenbuch tried this method on a patient with impassable stricture; hæmorrhage was free, the space opened was not large enough until a portion of the symphysis was resected; urinary infiltration and suppuration followed. There seems little to recommend this method.

## OPERATIVE TREATMENT OF BLADDER TUMORS IN THE FEMALE.

In women the removal of bladder tumors is rendered easier by the greater accessibility of the organ. In the case of malignant growths where drainage only, is sought for relief, the most natural means to employ is an opening through the vesico-vaginal septum. To secure continued patency of the wound, if desired, the edges of the wound may be sutured throughout their extent, or a large button, of the form of a shirt-stud, with a hollow center, may be inserted through the wound, one plate resting upon the inner surface of the bladder, the other upon the vagina.

The only advantage of the suprapubic route in malignant disease, as compared with the vaginal, is that, if extension of the growth occurs through the wound, it is more easily dealt with in the former.

The dilated urethra affords, for small and easily removable tumors, the safest and most satisfactory way, and in any case, except those in which it has been already determined that there is a large growth present, the urethra affords an easy and satisfactory road by which to determine the situation and characteristics of the tumor by digital exploration—the objection raised against the latter procedure in the male, that it involves an additional cutting operation, being absent in the female. If removal be impracticable by this route, the suprapubic or colpocystotomy remain. Of the last two, the advantage certainly lies with the former, in that it gives a satisfactory view of the interior of the bladder, and more room in which to work. The additional risk in a colpocystotomy, also of a vesico-vaginal fistula remaining, though small, is still something.

## ULTIMATE RESULTS OF OPERATION FOR THE REMOVAL OF BENIGN GROWTHS.

It is difficult to obtain a satisfactory judgment of the final results of these operations, owing to the facts that but few years have elapsed since these operations have been systematically practiced in considerable numbers of cases, and also that in but few of the cases reported has the subsequent course been noted.

The following series of cases, in which the author has found the history subsequent to operation indicated is small, and can give, therefore, but a very partial idea of what may be expected from the treatment, and it is presented in this sense only. Sir Henry Thompson gives the following summary of the results, immediate and final, of the operations which he had performed in forty-one cases, of which thirty-four occurred in male and seven in female patients:

"1. In seven cases there has been no reappearance of symptoms of any kind, three years having elapsed since the most recent, and nearly ten years since the first case of the series. All are living and well except one, who met his death by accident some two years after; but the bladder was examined by his medical attendant, after death, and sent up to the museum of University College Hospital, London, where it now is, together with the tumor originally removed; no trace of reappearance can be found in it. In every case but one the nature of the tumor was papilloma, the exceptional case being probably a myoma. In three cases the growth was removed by forceps through a perineal incision; in one female case dilatation of the urethra sufficed, and in the three remaining cases by suprapubic operation.

"2. In fifteen other cases death occurred at different periods, varying between three days and four months after the operation. Ten of these were the subjects of malignant growth of some kind, epithelioma and sarcoma in two or three varieties. Two were papilloma, apparently simple. The rest were myomatous, but contained nuclei which aroused suspicions of a grave character. It is worthy of remark that in five of this series papilloma was also present on the surface, and therefore probably as a secondary product to a more important growth, as myoma or sarcoma.

"3. Nineteen patients remain who lived after the operation for periods varying from about a year or a little less up to four years, one of these being now in good health (two years after the operation), much stronger and stouter than before, but is just beginning to note the reappearance of a little blood, and is, therefore, not entitled to be regarded like the first class, or those in whom the recovery was permanent."

In addition to Sir Henry Thompson's report, the eleven following cases of benign growths have been found, in which the result as to recurrence or death at a period exceeding four months has been noted:

1. Winckel. Female, aged thirty-nine. Papilloma. Removed per urethra by finger. Recurrence in five years.

2. Schutz. Female, aged eighteen. Telangiectasic fibro-myoma, three times operated. First, broken down and removed. Second time, same. Third, extirpated and base destroyed. First, great relief for one year. Second, operation for two years and six months. Third, recovery.

3. Marsh. Female, aged two. Papilloma. Removed by ligature. Death from exhaustion sixteen months later.

4. Alexander. Female, aged thirty-six. Papilloma. Removed by finger-nail per urethra. Recurred twice. Final result not stated.

5. Balleray. Female, aged two. Papilloma. Removed by ligature and scissors. Death six months later from exhaustion.

6. Davies Colley. Male, aged thirty-two. Papilloma. Long pedicle. Removed with scissors through a lateral lithot. Excision. No recurrence in four years.

7. Tiffany. Male. Papilloma. Removed through median perineal incision. Recurrence four years later.

8. Bernard Pitts. Male, aged forty-seven. Papilloma. Removed by a suprapubic cystotomy. Recurrence at end of two years after the first operation.

9. Watson. Male, aged thirty-one. Single papilloma, size of a Spanish chestnut. Removed by snare through a suprapubic cystotomy. No evidence of recurrence five years later. (Patient reported at that time.)

10. Watson. Male, aged thirty-six. Papilloma. Removed by curette through a median perineal incision. Recurrence one year later. Same operation repeated. Five growths removed by same means. Recurrence one year later, six growths were then removed through a suprapubic cystotomy by cautery scissors, curette, and ligature. Two years since last operation. Hæmaturia has just reappeared.

11. Watson. Male, aged twenty-four. Papilloma. Removed by curette through a median perineal incision. Died two years later of pyonephrosis. Autopsy showed the bladder to be absolutely free from any recurrence of the growth. Patient, who had had profuse hæmaturia, had no return of it after the operation.

### TREATMENT OF MALIGNANT GROWTHS.

The question of treatment in a case of malignant growth is less easily decided than in that of a benign one.

The means of determining the nature of the growth which were set forth under the heading of diagnosis may be briefly recapitulated as follows: If an area of induration can be felt by the finger in the rectum, if the patient be over fifty years of age, and if the cystoscope shows a growth with an ulcerated surface, which has raised irregular, ragged, everted, and œdematous edges. If pain be a marked symptom, the chances are strongly in favor of the disease being malignant.

The decision as to operation will depend, in such a case, upon the amount of pain or hæmorrhage present. It is difficult to see what objection can be raised to performing a palliative operation with a view to relieve pain or check hæmorrhage in this class of cases; and it is the author's decided belief that such should be done whenever either of these indications are present.

### DRAINAGE FOR RELIEF IN MALIGNANT DISEASE.

As has been mentioned, pain sooner or later becomes a prominent feature in most cases of cancer of the bladder, either from the presence of the growth itself, or from the cystitis which so frequently arises during its progress; to relieve this symptom or to check hæmorrhage, and to ease the vesical tenesmus which accompanies the latter when excessive, we can drain the bladder either from the perinæum or through a supra pubic cystotomy. Of the two, the author has found the latter the more satisfactory. The former may be entirely efficient if it is simply a question of relieving pain, but fails to give exit to the clots in cases of severe bleeding, and so fails to relieve. If the perineal operation is decided upon, the urethra is opened in the perinæum by the ordinary median incision upon a grooved staff; the neck of the bladder is then stretched by large sounds, and finally by passing the index-finger through it, and a large drainage-tube is inserted into the bladder through the wound and secured in place. For this purpose a large-eyed, soft rubber, or webbing catheter may be used, or, better, the large straight double tube devised by Reginald Harrison for perineal drainage, or the author's perineal drainage-tube, which was suggested for bladder drainage three years ago, and described as follows:

The perineal drainage-tube, which the accompanying cuts illustrate, was designed to secure thorough drainage of the bladder after external perineal urethrotomy, whether this operation be performed for stricture of the urethra, or as a preliminary step in the removal of bladder tumors, or for prostatotomies or prostatectomies, or for perineal cystotomy for any cause.

The essentials in such a drainage-tube are, *firstly*, that it shall have a thin wall and a large caliber. These are obtained by making the tube large and of thin hard rubber. *Secondly*, cleanliness and ease in keeping clean. Placing a large eye close to the end of the tube, so as to have no *cul-de-sac* beyond it, and the polished surface of the hard rubber accomplish these objects. *Thirdly*, the tube must have such a curve that its bladder end shall occupy the lowest part of the bladder, while the outer end shall lie in a parallel plane to the bed when the patient is on his back; the intermediate shaft must have the form and direction of the posterior urethra between the vesical orifice and the perineal wound.

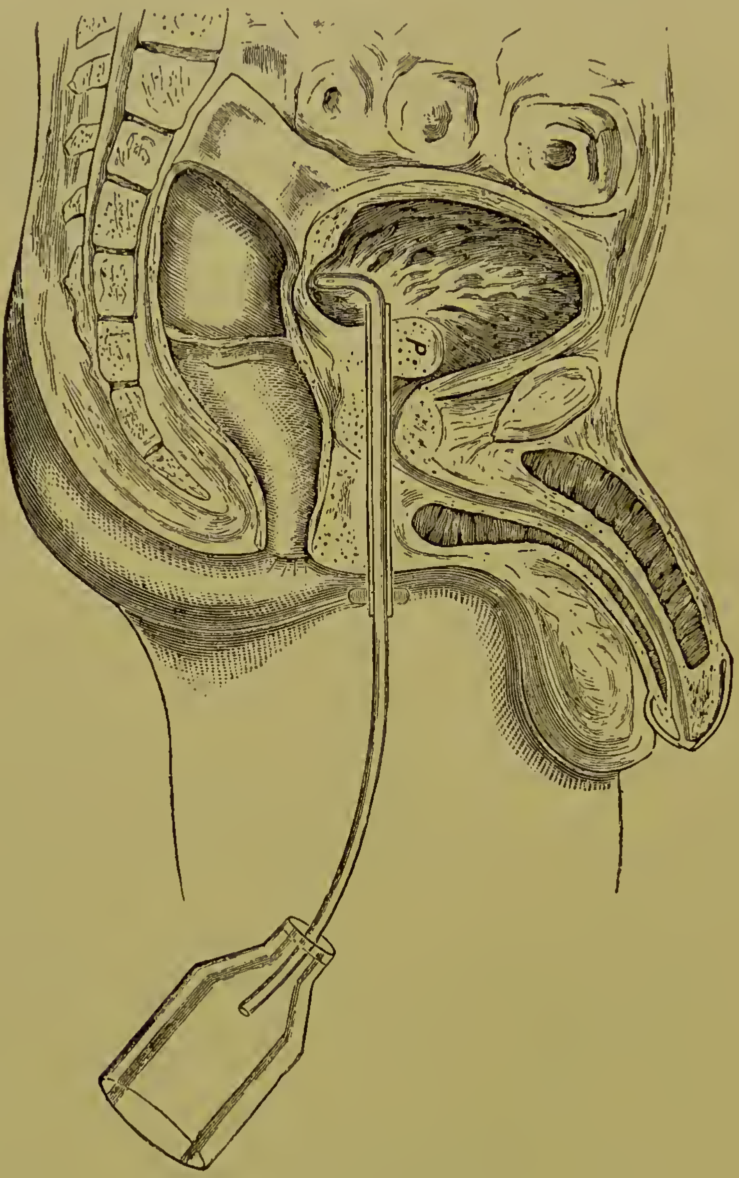

FIG. 24.—(After Harrison.)

To establish this curve, measurements were taken upon twenty cadavers (soft metal being used for the purpose). The shape and direction of the tube, as seen in the figures above, represent the average result of these measurements in an adult between the ages of thirty and fifty.

*Fourthly.* Inasmuch as the distance from the outer surface of the perineal wound to the bladder orifice varies more or less, owing to individual peculiarity, or to prostatic hypertrophy, and consequent lengthening of the prostatic urethra; and further, as the depth of the *bas fond* below the vesical orifice also varies in different instances, it is necessary, to meet the first indication, that it should be possible to shorten or lengthen this distance at will, to suit the individual case. This is secured in the construction of the plate and collar which surrounds the tube, which can be pushed forward or backward on its shaft by exerting some force, but will stay at the point at which it is placed.

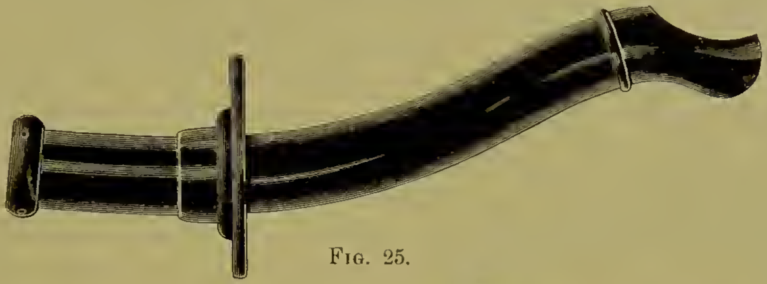

Fig. 25.

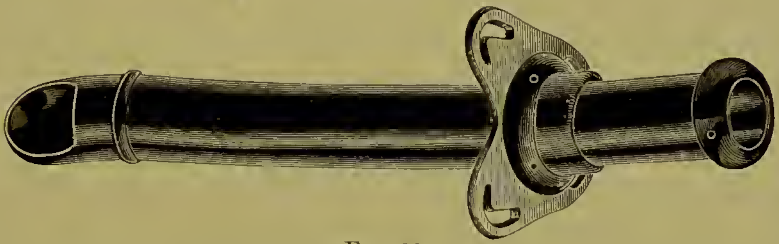

Fig. 26.

Figs. 25 and 26.—Author's perineal drainage-tubes.

To drain a deep *bas fond*, such as often occurs behind a median prostatic enlargement, the curved end of the tube which lies in the bladder is made longer in some of the instruments.

*Fifthly.* The collar is made to fit the perinæum, and has slots through which tapes are passed, by which it is secured to a waist-belt.

*Sixthly.* To guard against hæmorrhage—as, for instance, may occur in the course of the deep urethra after prostatotomy or prostectomy—some of the tubes have been made with a ridge just above the eye, so that they can be used as a *canula à chemise.* A raised edge at the outer end of the tube allows a bit of tubing to be attached, through which the urine can be led into a urinal.

The practical application of these tubes has been made in many cases by the author and by other surgeons, among them Reginald Harrison, who speaks favorably of them.

Where hæmorrhage from the bladder is likely to be abundant, as after removal of a bladder tumor, the large, smooth-sided tube gives the best chance for the exit of large clots.

These drainage-tubes are made of different calibers and lengths, and with or without the ridge which permits of their being converted into a *canula à chemise*, by Messrs. Codman & Shurtleff's, No. 13 Tremont Street, Boston.

These tubes require somewhat more care in their adjustment and more attention than the ordinary soft-rubber tubes or catheters do. Only ordinarily intelligent care, however, is needed to keep the tube in its proper place, and to have it perform its work satisfactorily.

In the presence of severe intravesical bleeding, however, the perineal operation is unsatisfactory, for the reason that it is difficult and often impossible to reach by this route the source of the hæmorrhage, and to check it; and if this is not done, the bladder will continue to be filled with clots, sometimes so dense and large that they can not make their exit through the perineal tube, no matter how large it may be, or what form it may have. In such cases, therefore, the suprapubic route should be selected by preference, and when this is done *the operation should be a free cystotomy* and *not a puncture with the retention of a canula*, or the insertion through a small opening of a catheter or single drainage-tube.

The danger of urinary infiltration into the prevesical space after the latter operation has been done was insisted upon by the author in his monograph upon The Operative Treatment of the Hypertrophied Prostate in 1888; and, moreover, if hæmorrhage is present, the bladder will not be efficiently drained by this means. The operation should be performed, if the purpose is for drainage for relief alone, just as though the intention was to remove the growth. By this means the dangers of the puncture are avoided, and the additional advantages are gained: (1) Of having room to seek out the source of the bleeding, and to check it by the application of cautery, curette, or ligature. (2) Of being able to empty thoroughly, and thereafter drain the bladder by the double siphon-tubes of Perier (already described). (3) Should an error of diagnosis have been made, and it be discovered on actual inspection that a benign and not a malignant growth be present, its removal can be undertaken. (4) Even if malignant growth be present, its partial removal (if the patient's condition permits) can be performed, and in some cases, especially those in which there is a large necrotic salient mass present, this should be done. For this substitutes a cleaner surface for the foul one, for a time at any rate, although it is true that these sprouting growths recur oftentimes very rapidly, and may invade the edges of the wound, and extend outward through it.

## RESECTION OF THE BLADDER.

In certain cases of cancer an attempt at removal of the growth, together with that portion of the bladder which it involves, is warranted by past experience, slight as it is. The cases suitable for such resections are necessarily rare, for they are only those in which the growth is situated at or near the summit of the bladder, and of limited extent. This implies an early diagnosis, and the site mentioned is, as already demonstrated, a rare one for the primary occupation of the growth. When the growth has deeply infiltrated all the layers of the bladder, and has involved the peritonæum as well, or, not having actually included the latter, has gone so far as to cause its intimate adhesion to the outer layers of the bladder, the peritoneal covering must of necessity be included in the resection. In this case the peritoneal wound should of course be at once carefully sutured.

If the fissure has not penetrated so far, the extra-peritoneal operation, as advised by Von Antal, may be performed, and offers a chance of success. This operation consists in the stripping off the peritonæum, and then resecting the affected portion of the bladder, uniting the wound so made by suture.

Another plan which may occasionally prove successful is that practiced by Guyon, of dissecting the growth from the deeper layers of the bladder without penetrating its outer coat. In one case Guyon states that he recognized the adipose layer described by Clado as sometimes to be found interposed between the base of a cancerous growth and the sound tissues beyond.

Barling, in an interesting article in the Birmingham Medical Review, cites the four following cases of bladder resection for cancer:

1. Bruce Clarke. Elderly man. Suprapubic cystotomy. Growth, a flat-celled cancer of the vertex of the bladder. Touched with cautery. A few days later the growth and a piece of the bladder wall three inches by two inches, including their whole thickness, were resected. The operation involved a cancerous piece of the peritonæum, wound of which was closed by suture. Death in a few days. No peritonitis.

2. Sonnenberg. Female, aged sixty. Suprapubic cystotomy. Resection two thirds of the bladder. Peritonæum extensively injured. Peritoneal part of the wound sutured. Death at the end of one month by exhaustion.

3. Von Antal. Male, aged fifty-one. Suprapubic cystotomy. Peritonæum stripped off. Growth size of child's fist on vertex of the bladder. Peritonæum stripped far back. One third of bladder resected with growth. Peritoneal cavity not opened. Recovery from the operation. Recurrence in one year.

4. Guyon. Male, aged fifty-five. Suprapubic cystotomy. Resection of growth about the size of last joint of thumb from right side of the bladder. Recovery. Death four years later from local recurrence. In this case the adipose layer, described by Clado as lying between the peritonæum and the deeper part of the bladder, was seen by Guyon.

Barling's conclusions as to operation in cases of cancerous growths are these :

1. The hope of cure by excision lies in the early diagnosis and operation before the patient's powers have been sapped by the disease, and before secondary changes due to obstruction or secondary growths have occurred.

2. For the rare cases in which the tumor is seated at the vertex. Antal's extra-peritoneal method (stripping back the peritonæum) should, if possible, be followed. By it about one half the bladder may be resected without opening the peritonæum (in favorable cases). Some of the muscular fibre is likely to be stripped off with the peritonæum. The bladder should be full during the attempt to strip off the peritonæum, as it is much more easily done when this is the case.

## SARCOMA.

Of twenty-one cases of sarcoma in which operation was undertaken, reported by Hinterstoisser, the results were as follows : Six extirpations through the female urethra ; two deaths due to the operation (one peritonitis from bladder perforation) ; two deaths after a few months by recurrence : four deaths ; two recoveries. Both were cases of small pedunculated tumors. One colpocystotomy, recovery. Seven median or lateral cystotomies. Three deaths ; two recoveries ; two not known ; deaths due to 1. Peritonitis. 2. Rapid recurrence. Five sectio alta : two deaths due to operation ; two from rapid recurrence ; one not recorded. Two lateral cystotomies immediately following sectio alta, which failed to allow of removal of growth : one death from recurrence in eight months ; one recovery. Total deaths following operation in twenty-one cases, twelve. Six recoveries. Three unrecorded.

The longest period without recurrence which the author has found recorded is that of five years in one case.

In connection with the subject of the removal of malignant growths, the following remarkable case of Paulik's is of especial interest, as indicating still further possibilities of a successful issue by the most radical of procedures.

## EXTIRPATION OF THE BLADDER IN THE FEMALE.

" The patient applied to his clinic on account of persistent hæmaturia. By catheterizing both ureters, hæmorrhage from the kidney was excluded. Digital exploration of the bladder revealed the presence of a polypus the size of an almond, which was removed per vaginam through an incision, its base being thoroughly cauterized. The patient was discharged cured. A year later she returned, extremely anæmic, stating that after enjoying good health for eight months the hæmaturia returned and had never ceased. Through the endoscope a diffuse papillomatous growth was seen, portions of which were removed for microscopical examination and proved to be malignant. The writer determined to extirpate the entire bladder, after turning the ureters into the vagina, in order to form a new bladder from the latter and the remains of the urethra. The preliminary operation was performed by inserting metallic catheters into both ureters (the patient being in the knee-elbow posture), incising the vagina opposite to the terminal extremity of each ureter, dissecting out the duct, and then ligating and dividing it two fifths of an inch from its opening into the bladder. The cut end of each ureter was then stitched into the corresponding vaginal wound after removing the catheter; after healing had occurred there were thus formed two utero-vaginal fistulæ. Three weeks later the radical operation was performed. An incision was made as for a suprapubic lithotomy, the peritonæum was dissected from the bladder, and the latter was separated from its attachments as low down as the urethral opening, the organ having been previously distended with an iodoform emulsion in order to render it more prominent. At this stage the bladder was emptied, and the cavity already made was packed with iodoform gauze on account of the oozing. The anterior vaginal wall was now incised just above the most prominent part of the urethro-vaginal septum, the bladder was drawn down through the wound and was cut away at the vesical orifice of the urethra.

"Here the patient collapsed, but was revived by the subcutaneous injection of ten ounces of warm salt solution, and the operation proceeded. The anterior vaginal wall was sutured to the anterior border of the urethral wound, the posterior border being united to a freshened surface at the entrance of the vagina in such a way as to produce a kolpokleisis. Before the sutures were tied, elastic catheters were introduced into the urethra and carried into the ureters. The abdominal wound was closed, except at its lower end, through which were carried the ends of the gauze for drainage. The patient made a good recovery, but a fistula remained which communicated with the cavity that had formerly been occupied by the bladder, which did not heal for eight months. A second unsuccessful attempt at kolpokleisis was made ten months after the primary operation. This was repeated a month later, the anterior and posterior walls being united transversely; a minute fistula remained behind the urethra, through which urine escaped only when the patient was in an erect posture. She was able to retain control of her artificial bladder until twelve ounces of urine had accumulated, when she could empty it by contracting the perineal muscles. The woman made a perfect recovery and was able to undertake a journey from Prague to Berlin, and to spend several days in sight-seeing."—*American Journal of Medical Sciences, January, 1891*, p. 101, No. 225.

In this connection also are to be mentioned the following cases which antedate the case of Paulik's reported above, and are, so far as the author knows, the first examples of the total extirpation of the bladder or its mucous membrane in the living subject. They are reported by Brohl (Wiener Med. Presse, 1889, Nos. 27 and 28), the operations having been performed by Von Badenheuer :

Case I. Fifty-seven-year-old patient; a tumor occupied the larger part of the base of the bladder — the bladder was extirpated (the symphysis pubis being partially divided to expose the organ); for ten days the progress was favorable. Death on the fourteenth day from uræmia.

Case II. Girl, seven years old; primary tuberculosis of the bladder, mucous membrane of the bladder extirpated. Recovery. Death eighteen months later from tubercular peritonitis.

Case III. Man sixty-four years old. Entire interior of the bladder occupied by disseminated cancerous (?) growths. Excision of the whole of the mucous membrane of the bladder, and resection of a large area of the posterior wall, which was occupied by a large single tumor. Recovery.

Case IV. Man, aged thirty, multiple small tumors of the bladder; total excision of the mucous membrane. Recovery.

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# STONE IN THE BLADDER, PROSTATE, URETHRA AND URETERS.

By ARTHUR T. CABOT, M. D.

## I. STONE IN THE BLADDER.

**Definition.**—It is not easy to state concisely what constitutes a stone in the bladder; and Surgeon-Major Freyer was criticised by Sir Henry Thompson for including in his statistics stones weighing less than twenty grains. In reply, he pointed out the fact that under some circumstances the removal of small stones was a matter of considerable difficulty and danger; and it is to be borne in mind that before the introduction of lithotrity even small stones required serious cutting operations for their removal. A stone in the bladder may be defined as a concretion which the bladder is unable to expel by its natural efforts, and which therefore requires surgical interference for its removal.

**Chemical and Physical Characteristics.**—These concretions are composed mainly of salts, or solid constituents of the urine, which are thrown down in a more or less crystalline form, as will presently be shown. Urinary calculi may be classified according to the principal ingredient which goes into their composition, and may accordingly be divided into the following groups:

1. Uric stones, composed of uric acid and the acid urates.
2. Oxalic stones, composed of oxalate of lime.
3. Phosphatic stones, which contain phosphates and carbonates, not infrequently combined with urate of ammonia.

We have also in the urine certain organic substances which sometimes exist in such amounts as to be deposited in the shape of calculi. Of these, cystin is the most common, but concretions of it are of very unusual occurrence. Xanthin and indican calculi have been reported, but are exceedingly rare. Occasionally hæmatoidin and coloring matters from the urine are found in stones, but rarely in any quantity. Cholesterine and fatty materials have been observed, and a few instances of fibrinous masses in the urine are reported. These rarer constituents of urinary concretions have a scientific interest in connection with the chemistry of the body, but are so infrequent as to be of little practical importance. For ordinary purposes the division into uric, oxalic, and phosphatic stones sufficiently distinguishes the different kinds we meet.

While a calculus is to be referred to one or other of these classes, according to the character of its main constituent, it is not unusual to find one belonging partly in one group and partly in another. Thus, for instance, a stone with a uric-acid nucleus will often have an oxalate of lime sheet or layer around it, and outside of that again a phosphatic layer. Sometimes several constituents are mixed more or less evenly throughout the stone. Thus a uric-acid calculus may contain oxalate of lime distributed through it. The phosphates and carbonates are usually thus combined.

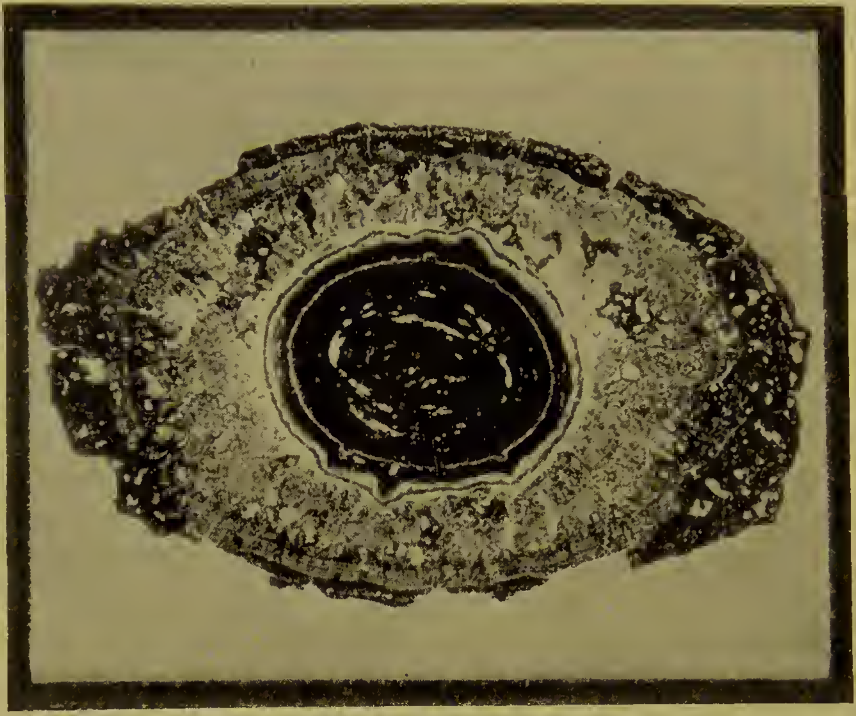

Fig. 1.—A stone having a nucleus of urate of soda, a middle layer of oxalate of lime, and an outside layer of earthy phosphates.

If the crystalline matters are dissolved out of a stone, an albuminoid mass is left, which has served as the skeleton in which the salts were deposited. This framework or basis substance exists even in the minutest bits of sand, and in oxalate stones is partly made up of cells, which Ebstein believes to be epithelial cells, and in which he has shown the oxalate of lime to be actually deposited. Cystin stones have less of this albuminoid skeleton than the other urinary calculi.

The researches of Rainey, Harting, Ord, Ebstein, and others indicate that the formation of stone is not a simple process of deposition of salts existing in excess in the urine. Indeed, instances are of every-day occurrence in which uric acid, the urates, oxalate of lime, or the phosphates are present in solid form for long periods of time in the urine without leading to stone formation. The investigations of these observers have shown the crystalline substances of the urine to follow the law of "molecular coalescence" laid down by Rainey and elaborated by later observers; which is, briefly, that "in the presence of colloid or albuminoid substances crystalline materials become spheroidal in shape and coalesce in rounded form." Following this law, in the urinary passages crystals of uric acid in their usual rhomboidal shape may for long periods be thrown down, washed along, and passed out with the urine without showing any tendency to form concretions. Finally, the irritation of the urinary tract leads to the exudation of albuminoid material, which, acting on the crystals, changes their molecular form and creates in them the tendency to coalesce. The necessary albuminoid material may be supplied in other ways. Necrotic bits of tissue are, as is well known, likely to be incrusted with lime salts. Masses of bacteria and bits of blood-clot are also found in stones, but what part they play in the formation of the stone is not clear. The concretion, once started, continues to act as an irritant to the wall, and so continues to be supplied with an albuminoid envelope, in which successive layers of spheroidal crystals are deposited.

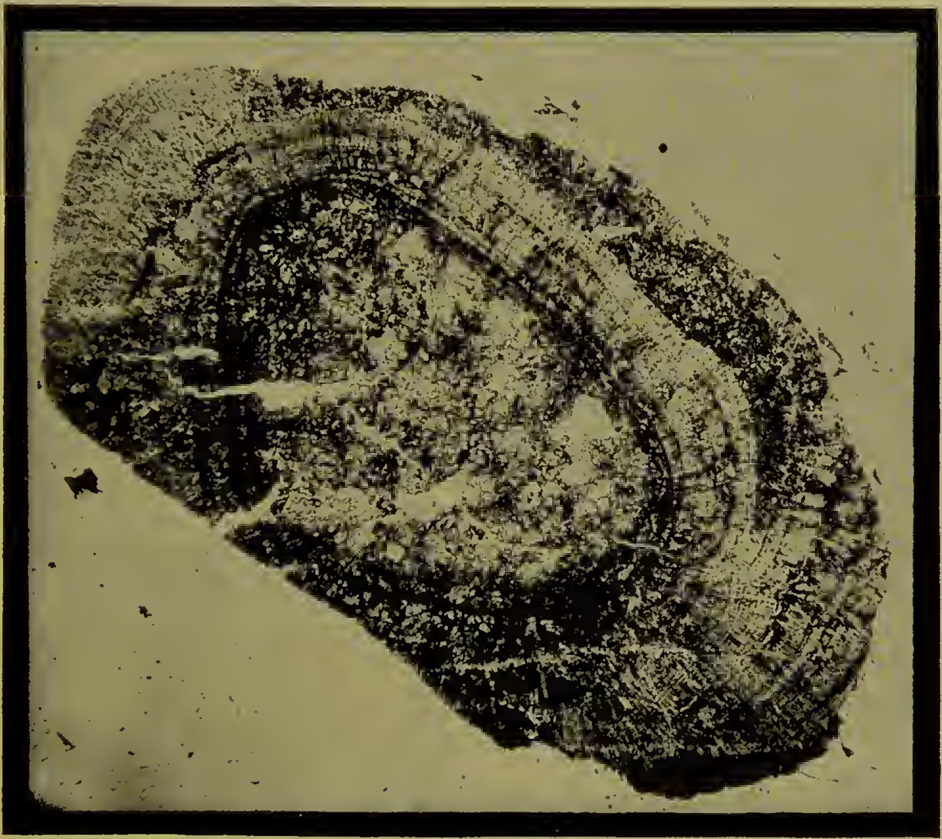

FIG. 2.—A uric-acid stone, showing a nucleus, partly granular partly crystalline, surrounded by well-marked concentric layers.

Ultzmann (Die Harnconcretionen des Menschen und die Ursachen ihrer Entstehung), by a study of thin sections of stone, arrived at conclusions somewhat at variance with these. He obtained sections thin enough to make good microscopical preparations, and his study of these led him to think that "stone formation in man does not consist in a simple agglomeration of sedimentary substances held together by an organic basis material, but that it is a real cyrstallization (Massen Krystallisation), which follows common crystographic laws." Unfortunately, Ultzmann seems entirely ignorant of the researches of Rainey, Ord, and others, on changes in crystalline form brought about by the presence of an albuminoid in the mother-liquid; and, having shown in his thin sections that there is often a more or less regular crystalline form, he jumps to the conclusion that he has hereby disproved all of the hypotheses that require an organic basis substance in the building of a stone. He even denies the existence of such an organic skeleton, on the ground that he sees no traces of it in his thin sections. Apparently, he never tried the experiment of dissolving out the solid constituents, and so demonstrating the existence of the albuminous framework.

Although he draws such hasty and unproved conclusions from his study of his sections, they will be found interesting and worthy of close inspection, and some of them are accordingly copied here. Being reproduced from micro-photographs, they tell the truth as far as the imperfections of the photographic process allow. In many of them (Figs. 2, 3, and 6) the globular character of the crystals may be seen, and they confirm the accepted opinion as to the effect of the surrounding albuminoid on their manner of crystallization. In some sections, which show these rounded forms quite well, are to be found places in which the crystallization has more of an angular character, and it is on these appearances that Ultzmann founds his conclusions. Even in these more regular crystalline forms the corners of the crystals are usually rounded, as if the molding tendency of the albumen had been partly felt.

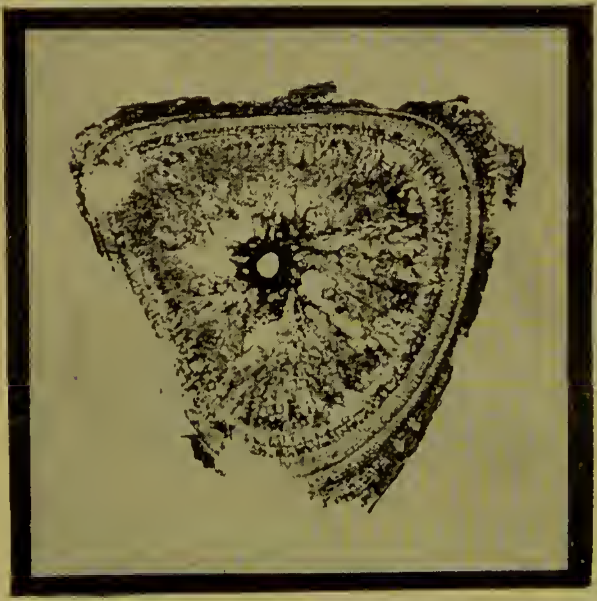

FIG. 3.—A stone composed of earthy phosphates. In the central portion it shows the radiating striæ, surrounded by outer concentric layers.

A superficial examination of the plates shows the concentric formation of these stones, with more or less plainly marked rings or zones (Figs. 2, 3, and 4). This appearance reminds one of the rings seen on the bole of a tree when cut across; and, as the rings on the tree mark the cycles of its growth, so the layers of the stone give evidence of varying conditions which surrounded it during its formation—variations in the rapidity of the deposition of salts at different times causing changes in the compactness of the layers.

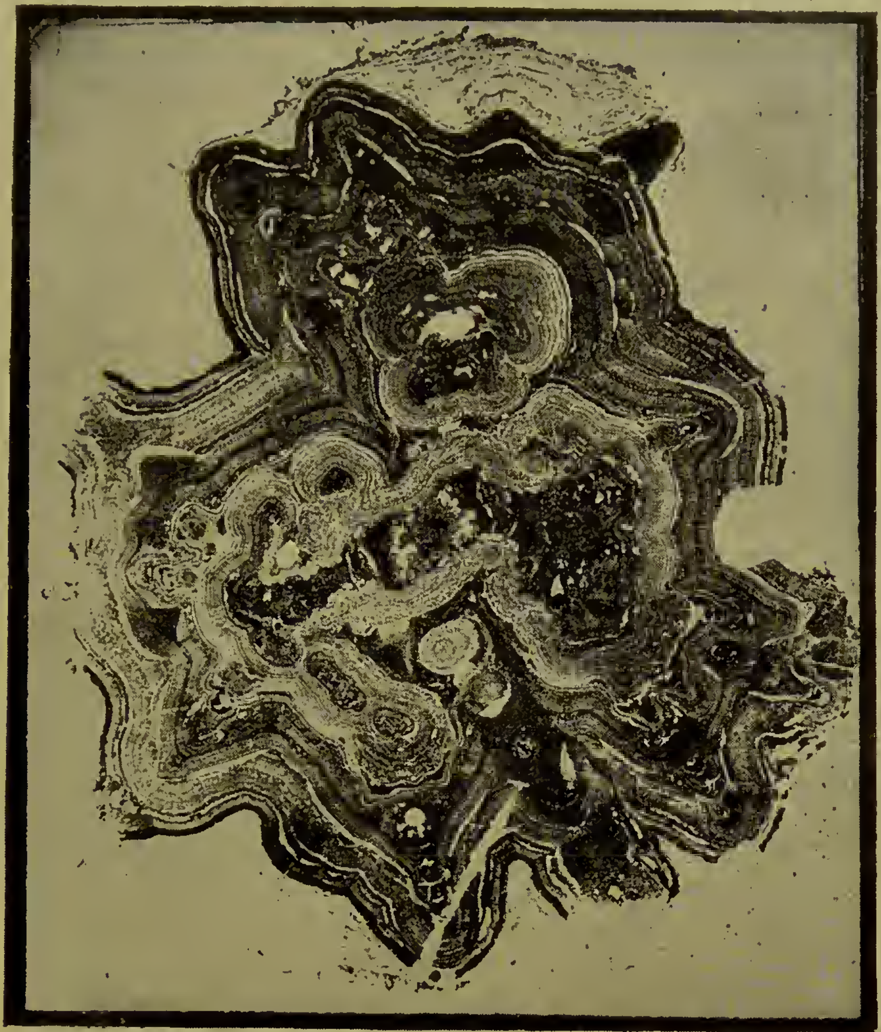

FIG. 4.—A stone composed of oxalate of lime and uric acid, showing the manner in which several nuclei may coalesce to form one stone.

Further inspection will show in most of them an indistinct striation radiating from the center, and extending out through the concentric rings. Figs. 3 and 6 give an indication of this formation, and in the section of an oxalate of lime stone (Fig. 5) these striæ are seen as distinct lines of cleavage. Considerable portions of these stones show an irregular, loosely crystalline character, which may be seen in the central portion of the sections in Figs. 2 and 3, and which prevail throughout Fig. 6, being only partly interrupted here and there by more compact rings. Ebstein calls attention to the fact that in some stones the nucleus is made up of an irregularly grouped mass of little rounded bodies, while the outer portions are arranged concentrically, and show radiating striæ. A condition somewhat approaching this may be seen in Fig. 2, although here the nucleus has a more crystalline appearance than he describes.

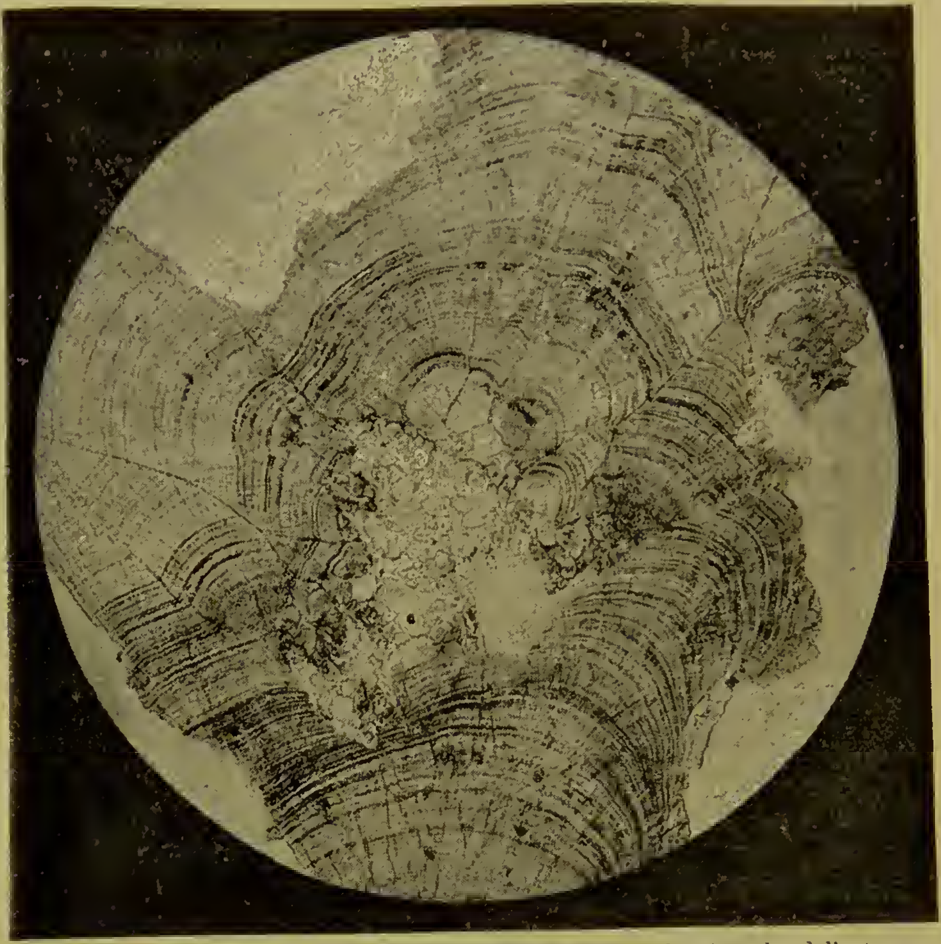

FIG. 5.—A highly magnified section of an oxalate-of-lime stone, showing the delicate concentric layers and the radiating striæ.

From these variations in structure it may be inferred that the conditions under which the crystallization takes place are not constant, and it is reasonably certain that the amount of albuminoid about the stone has a decidedly molding effect on the crystals, which, when this is in relatively small amount, may keep more nearly their ordinary crystalline form.

Bearing upon this point I have made the following observation: In a patient with some residual urine, who was constantly passing uric-acid crystals, a stone presently formed. The urine remained clear to the eye, although under the microscope it was seen to contain a few blood and pus cells. The stone was crushed and pumped out. It was very friable, and consisted of almost pure uric acid. There was so little cohesion in this stone that the fragments, after being dried and bottled, fell apart into fine dust, simply from the shaking they underwent during a few hours in my coat-pocket. An examination of this dust under the microscope showed that the uric acid had a distinctly crystalline form, not globular. The crystals were mostly of rod or needle shape, with here and there rhombic plates. This stone, which formed in a urine almost free from pus and albumen, thus retained a more decidedly crystalline character than usual. Its extreme friability showed the absence of cohesion between crystals of this form, when not held together by an albuminous binding material.

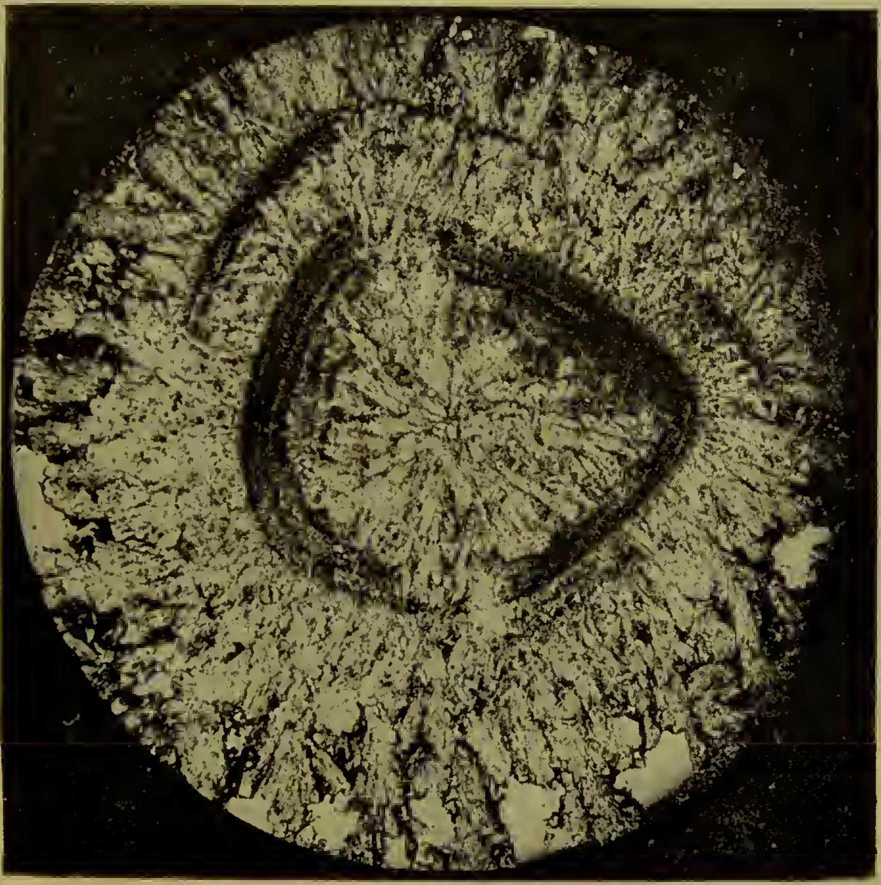

Fig. 6.—A cystin stone, showing the radiating striæ, partially interrupted by imperfect concentric layers.

**Color.**—The color of a stone varies according to its constitution. Uric acid and the urates make a red or yellowish-red stone. Oxalate of lime is brown or gray in color, often so dark as to be practically black. Phosphates and carbonates are almost white, shading off into gray.

**Consistence.**—They differ greatly also in their degree of compactness and hardness. Oxalate-of-lime stones are the hardest, often being so firm as to require great force to crush them with the lithotrite, and resisting any but the strongest instruments. Stones made up of urates are somewhat less hard, while phosphatic stones, and some of those consisting of pure uric acid, are the softest, offering usually but little resistance to crushing instruments.

**Shape.**—The shape of a stone is governed, in the first place, by the more or less even deposition of the crystalline substances about it; secondly, by the friction of the containing walls; thirdly, by friction of other stones; lastly, by the molding of surrounding walls, as when it forms in a canal such as the ureter or urethra, or in a pocket in the bladder. This molding is particularly well seen in the stones which form in the kidney, which often take the exact shape of the calyces of that organ. Occasionally a stone is made up of an agglomeration of several stones, which, after existing independently for a time, cohere. This is seen in Fig. 4, which further shows the irregularity of shape which may arise from this arrangement.

**Surface.**—The surface of a stone varies according to the constitution of its outermost layer. If this is composed of uric acid, or the urates, it gives a tolerably smooth surface. A phosphatic stone is somewhat rougher, and an oxalate-of-lime stone has an extremely rough, often prickly or knobby, surface (mulberry calculus).

**Number.**—Stones usually exist singly in the bladder, but it is not an infrequent occurrence to find more than one; and sometimes several hundreds are found in one bladder. When many exist, they are ordinarily small, with rounded outlines. As they become larger and rub against each other more evenly and firmly, they wear off surfaces and become faceted. This action is particularly noticed when the stones are confined in a pocket where they are held in close apposition. Sometimes this mutual molding leads to the formation of regular prominences on some of the calculi which are not of satisfactory explanation. In Fig. 7 we have a drawing of such calculi, in which curious projections have been developed quite symmetrically on many stones: *a*, *a*

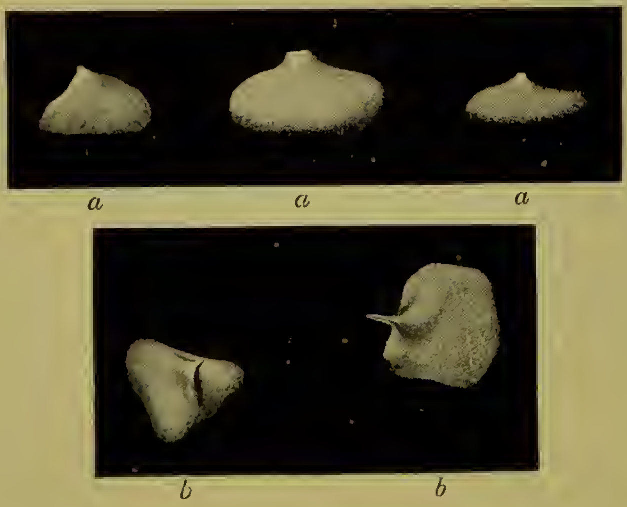

FIG. 7.—Multiple calculi with curious projections.

are drawn from stones removed by me in a case of multiple calculi; and *b, b* represent similar stones obtained by Mr. Buckston Browne in a similar case.

**The Spontaneous Fracture of Stones.**—This phenomenon had already been recognized and somewhat investigated by earlier writers (Von Schaden, Schmidt), but the researches of Ord were the first to bring forth an adequate explanation of it. Rainey, when investigating the laws of "molecular coalescence," found that spheres of carbonate of lime which had been formed in a solution of gum would split up radially and again disintegrate if they were placed in solutions of a different specific gravity. This effect was even more noticed when the spheres were composed of mixed carbonate of soda and triple phosphates. Following this suggestion, Ord believes that the splitting up of a urinary calculus is, in a similar way, due to the action of urine of a different specific gravity and reaction from that in which the calculus formed. He thinks that the colloid material in the stone swells by imbibition of urine of a different density, and that the nucleus, becoming thus enlarged, breaks the outer enveloping layers by an "explosive disruption such as would occur in a thick-walled shell." In three of Ord's cases the fragments, which were of uric acid, were covered with a little urate of ammonia, by which fact he was led to surmise that the urine had become alkaline, and that to that change was partly due its action on the colloids of the stone.

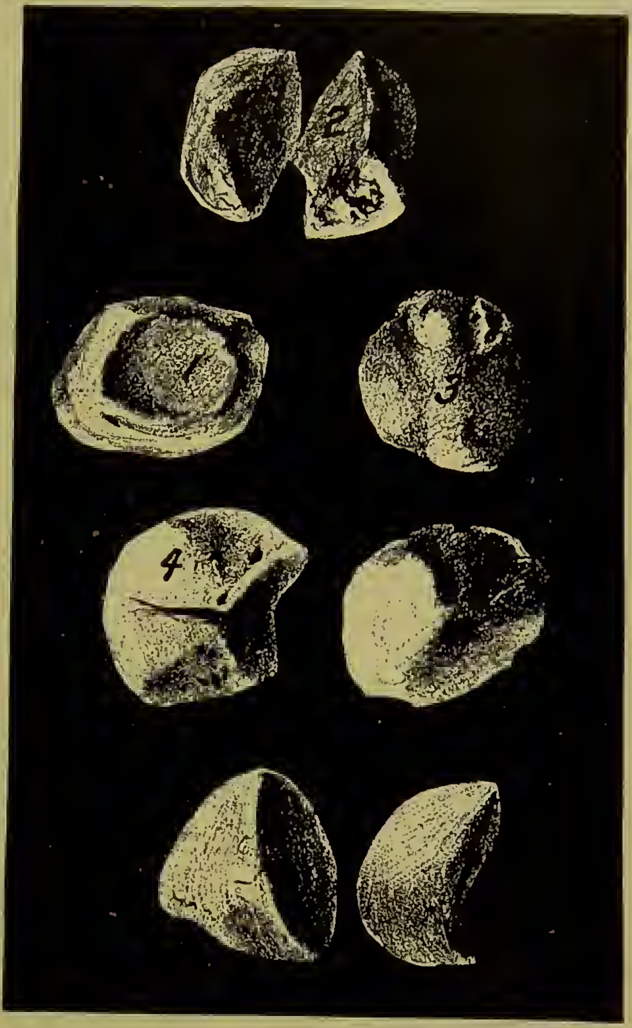

Fig. 8.—Fragments of a stone spontaneously fractured in the bladder.

The splitting of calculi under these conditions follows the radiating and concentric lines which we have seen to exist, and the fragments show a tendency to assume wedge-like forms. The accompanying figure (8), taken from Watson, shows very beautifully the shapes thus formed. In his case, from which these fragments came, the disintegrated uric-acid stone was found in the bladder after death. The *débris* weighed in all about 160 grains. In No. 1 it may be seen that the outer phosphatic layer has shrunk somewhat in drying, and has formed little radiating cracks through it, which suggest very well the way in which it would break up if the stone within swelled from any cause.

Ord has recorded a case in which an actual molecular disintegration of a calculus seemed to have occurred, similar to that observed experimentally by Rainey in his carbonate-of-lime spheres. It seems probable that some of the reported cases of the solution of stone in the bladder by the drinking of certain lithia or other spring waters, in which the patients have passed large quantities of *débris*, are instances of spontaneous fracture, brought about by the great alteration of the specific gravity of the urine, due to the continuous drinking of an excessive amount of water.

Some observers have thought that several calculi might be so pressed together by the contracting bladder, or might strike against each other in such a way as to lead to their mutual fracture. In a specimen of spontaneous fracture met with by Croft, there was a soft, friable layer between two harder layers; and Ord points out that "this is a condition favorable to fracture, when two or three calculi of about the same size and the same constitution are present in the bladder together. They crack each other's shells, like eggs carried loose in a bag."

**Etiology.**—In considering the circumstances that lead to stone formation we have two sets of causes to investigate: First, the general conditions and tendencies, diathetic and otherwise, that induce the overproduction in the system of the materials which are deposited from the urine in the shape of calculi; and, secondly, certain local conditions which favor the deposition of these solids out of the urine. We will first consider the general conditions concerned in their formation.

**Locality.**—The irregularity of the distribution of stone through different countries and localities has given rise to much speculation, and various theories have been advanced to account for it. The frequent occurrence of these cases in the central states of North America, and in other localities having a similar geological formation, was thought by some writers to be due to the limestone underlying those places, and causing a strong impregnation of the drinking-water with lime-salts. This theory falls to the ground, however, when it is seen that the tendency to stone is not evenly distributed through the countries where lime abounds, and that it shows itself at times in but one part of such a district.

**Heredity.**—That heredity may have an influence in determining a predisposition to stone is undoubtedly true, and many instances are reported in which the uric-acid diathesis has existed through several generations in a family, and has made its members liable to the occurrence of calculous disease. Whether a tendency to oxaluria or phosphaturia is similarly transmissible is not so clear. The influence of heredity has been evoked as one factor leading to the frequency of stone in certain neighborhoods, where generations of intermarriage might fix calculous tendencies on the people. The amount of effect that this may have is not easy to trace.

**Diet and Habit.**—The influence of diet and of habits of life upon the excretion of uric acid and oxalate of lime is unquestioned. Thus, the customs of a people, their ways of living, and their choice of food, may have a decided influence on the frequency of stone among them. Uric acid and oxalate of lime are often found abundantly in the urine of poorly nourished children, in whom the processes of digestion and of oxidation of tissues are imperfectly accomplished; also in older individuals who take large quantities of nitrogenous food, and whose functions are sluggishly performed. It is therefore in these two classes that acid stones most commonly form. Thompson has pointed out the fact that stone is common among the children of the poor, while among the rich it spares the children and appears among the old men. This observation refers only to primary calculi; for secondary calculi, due to fermentation of the urine, are more common among the aged poor, who pay but little regard to a moderate cystitis. In the case of oxalate of lime, its appearance in the urine may come about in a way even more direct; for the ingestion of certain articles of food that contain oxalic acid abundantly often leads at once to the deposition of large amounts of oxalate of lime in the urine. Chismore has found oxalate-of-lime stones disproportionately abundant on the Pacific coast of North America, and is inclined to ascribe this to the fruit-eating habits of the people.

Recent investigations of Ebstein and Nicolaier throw some light on the manner in which a chemical substance may be carried through the body without change, and be deposited out of the urine in the form of a stone. They fed animals (dogs and rabbits) on oxamid, an ammonia derivative of oxalic acid, and succeeded in causing the formation of numerous oxamid stones in the urinary passages. As oxamid never appears in the urine under normal conditions, these experiments are convincing proofs of the possibility of this method of stone formation directly from substances contained in the ingesta.

**Diathesis.**—Besides the general conditions of life which have an influence on the frequency of primary stone formation, we have also to consider certain tendencies peculiar to the individual which favor the occurrence of calculous disease. The existence of a uric-acid diathesis has been alluded to as having been invoked to explain the frequency of stone in certain localities, and the hereditary transmission of this diathesis is generally recognized. Its association with various gouty lesions is so constant that it is properly looked upon as one manifestation of gout; and it is not uncommon to find, in a family with a strong inheritance of gout, one or more individuals suffering from uric-acid gravel, or from stone in the kidneys or bladder. It has been observed that patients suffering from hepatic disease are liable to an excess of uric acid, and the same is true of diseases of the spleen. In leucocythæmia the presence of large quantities of uric-acid crystals in the urine is of frequent occurrence, and the formation of stone in the bladder under these circumstances has been recorded.

When we come to the consideration of phosphatic stones, we find quite a different condition of things; for, although it may occasionally happen that the phosphatic diathesis gives rise to the formation of a calculus, it is far more common to see a stone of this kind the result of a local process.

**Alkaline Fermentation.**—In chronic inflammation of the bladder, sooner or later the urine is likely to become alkaline, and to throw down crystals of triple phosphate as well as of other alkaline salts. These are thickly deposited in the gelatinized pus, erroneously called mucus, and in this they undergo the molecular changes that lead to their coalescence, and agglomerate themselves into little masses, around which the subsequent formation of the stone goes on quite rapidly. Any condition that predisposes to chronic cystitis and alkaline fermentation of the urine may be regarded, therefore, as an etiological factor in stone formation. The condition most favorable to alkaline fermentation is that of partial retention (residual urine). This is usually the result of some obstruction, rarely of atony. The common cause of obstruction is an enlarged prostate, but a stricture often acts in the same way. I have met with a number of cases of stone which have thus formed behind a stricture. The production of alkaline fermentation is not the only way in which an obstruction to the flow of the urine favors the tendency to the formation of stone. In the healthy bladder, which completely empties itself at each act of micturition, any crystals which are deposited in the urine are washed out with it, and any little stones that come down from the kidneys are usually expelled in a similar way. When, however, owing to an obstruction, the bladder ceases to thoroughly expel its contents, the chance of a commencing concretion being thrown out is diminished, and thus the formation of a stone in the bladder is much more likely to occur.

Sometimes a patient is for years subject to attacks of renal colic, and during adult life the small stones which pass down from the kidney are successfully voided, until finally as he advances in age the prostate becomes enlarged, the bladder ceases to entirely empty itself, and a renal stone, being retained, forms the nucleus of a stone in the bladder. In the same way a sacculated condition of the bladder favors stone formation, for in the pouches, fermenting urine and mucus are retained, thus producing conditions suitable for the origination and rapid progress of calculous deposition.

**Symptomatology.**—A stone may exist for a considerable time in the bladder without causing the least discomfort to make its presence known. I on one occasion touched a stone in the bladder, and, because the patient could not then attend to it, left it undisturbed; but the man went for several months in perfect comfort before symptoms appeared which finally led to an operation. In this case the stone lay in a post-prostatic pouch, and did not come in contact with the sensitive vesical neck either during motion or after urination. Such cases are not very uncommon. Occasionally we see a case almost the exact opposite of this, in which most of the uncomfortable symptoms that are ever associated with a stone in the bladder are heaped upon the unfortunate victim. Most of our patients, however, occupy the middle ground between these extremes, and, while presenting some of the symptoms in a more or less characteristic form, may be wholly without other sensations and phenomena that we usually expect.

The following are the symptoms that we have to look for in these cases, and I have taken them up in the order of their importance:

**Pain** is a very constant accompaniment of stone, and, although other evidences of irritation may precede it, it is perhaps the most characteristic symptom that we have. The pain of a stone varies greatly in intensity, and is referred to somewhat different localities in different cases. There may be merely a sense of discomfort and weight in the perinæum and rectum, or a burning may be felt in these same regions. When more severe, a lancinating or pricking pain may be felt; and I have had a patient insist that he had exactly the feeling as if a paper of pins were in the lower bowel, just within the anus. These pains show a tendency to shoot out along the urethra and into the testes, or down the thighs. Not infrequently the pain is all referred to the end of the penis, and the dragging upon this organ in the effort to relieve discomfort sometimes causes a considerable elongation of it. In children a greatly lengthened prepuce results from the same habit.

Wherever the pain is felt it is almost invariably aggravated during and after urination. As the bladder closes down on the surface of the stone, the irritation is increased. At this time the pain is almost certainly felt, in part at least, in the glans penis. This is due to the fact that the stone is pressed down against the prostate as the bladder empties itself, and irritations at the bladder face of the prostate are referred to the glans penis. Occasionally sharp spasms are set up in the bladder as its walls come in contact with the stone. As might be supposed, the increase of pain at the end of urination is often absent in a patient who does not completely empty the bladder; and, in that case, it may make its appearance if the residual urine is drawn with a catheter.

Another characteristic of this pain is that it is aggravated by motion. If the stone is movable in the bladder, it is natural that it should be more irritating when rolling about than when lying still. Riding in a jolting vehicle is the most trying kind of motion; but often the sensitiveness is so great that quiet walking can not be endured, and some patients even suffer greatly from turning over in bed.

Other things being equal, a stone causes more pain when resting near the neck of the bladder than when lying back toward the fundus, so that these patients are often more comfortable when lying in bed with the hips raised than when in a more upright position.

**Increased Frequency of Urination** is so constant a symptom in all inflammatory troubles of the bladder that its appearance would not arouse a suspicion of stone. The fact, however, that in stone cases the frequency is much increased by motion may be of assistance in deciding on the probable diagnosis. Especially may a study of this symptom assist in differentiating between stone and enlarged prostate; for, while the stone patient will probably be less called upon to urinate at night than in the day, the reverse is apt to be true in the prostatic case, for the passive congestion of a hypertrophied prostate is aggravated by recumbency, and is usually somewhat relieved by exercise. The frequency, dependent on the presence of a stone, may be slight in degree, or may be so extreme that the patient urinates every few minutes, and sometimes suffers from a true incontinence. The efforts at urination often induce painful spasms of the bladder and rectum, and prolapse of the bowel sometimes follows severe straining.

**Sudden Stoppage of the Urine in Full Stream.**—It sometimes happens that the stone rolls over the internal orifice of the urethra during urination and thus causes a sudden stoppage of the urine, accompanied by a sharp twinge of pain, with often considerable straining following it. Under these circumstances the patient usually finds that, after a moment's pause, especially if he changes his position, the urine will again flow and the bladder will empty itself. In the recumbent position this stoppage is less likely to occur, for the obvious reason that the stone then lies at a distance from the vesical neck. This symptom is more common in young and middle-aged patients, and is rarely observed in the old. The reason of this is easily seen; for in the undistorted bladder of youth the vesical orifice is dependent when the body is erect, and the stone readily falls upon it. In old age, on the other hand, after the development of the post-prostatic pouch, the stone gravitates into this, and can not easily roll forward on to the urethral opening. Furthermore, the irregularities of the vesical orifice in old men, caused by projections from the prostate, especially of the third lobe, make it difficult for a stone to fit into and close it tightly. And, lastly, when the bladder has lost its force, the slowly flowing stream is less likely to carry the stone along with it.

**Hæmaturia.**—The presence of blood in the urine is a usual accompaniment of calculus, and is the direct result of the injury done to the bladder walls by the stone. It is usually slight in amount, often requiring the microscope for its recognition. Occasionally in patients having the hæmorrhagic diathesis, or in old persons with congested prostates, it may assume serious proportions.

Violent motions have a marked effect in increasing the hæmorrhage. The blood may be mixed evenly in the urine, giving it a smoky or red color. It may, however, come at the end of urination, the first portion of urine passed being clear and the last few drops containing much blood, which is pressed out as the bladder closes on the stone. This expulsion of a few drops of blood at the end of urination is not, however, at all characteristic of stone, for the same thing is observed in inflammatory troubles about the prostate, and also sometimes in cases of tumor of the bladder.

**Cystitis.**—It is common, sooner or later, to see a cystitis develop itself in connection with a stone, and the symptoms are then complicated by those of inflammation of the bladder. Under these circumstances the pain is usually more intense, and the frequency of micturition is a more prominent symptom.

**The Condition of the Urine** often gives important indications in cases of stone.

Before a cystitis develops the urine may be quite clear to the eye, but even then a microscopical examination will usually show the presence of crystals of uric acid or oxalate of lime, with a few blood and pus cells. Patients sometimes state that for a long time the urine contained red sand, but that finally this disappeared, and soon after the symptoms of stone began. This would seem to show that, after the stone formation has started, crystallization around it removes in some cases the over-abundance of uric acid. This observation depends, as far as the author is concerned, on the statements of patients, and it is to be remembered that, in persons who have no stone, crystals of uric acid will appear intermittently in the urine. Still, in view of what is known about the change which takes place in the crystallization of uric acid when albuminoid materials have become mixed with the urine, it seems possible that this observation is founded on more than a mere coincidence, and that the change marks the commencement of "molecular coalescence" of the uric acid.

When cystitis develops, the urine becomes more or less cloudy, owing to the admixture of pus and bladder epithelial cells. Usually crystals are found in connection with the evidences of bladder inflammation. If the urine continues acid, as it not infrequently does, the crystals may be those of uric acid or calcic oxalate. If the urine becomes alkaline, the uric acid usually disappears, and we have crystals of the triple phosphates, of the carbonates and urates. The alkaline condition of the urine also induces a change in the condition of the pus, which becomes slimy, and clings together in stringy, coherent masses, which often adhere to the bottom of the vessel in which the urine has stood. The pus, thus altered, usually passes by the name of mucus, but it is not the excretion of the mucous glands.

When there is ulceration of the bladder walls the amount of pus in the urine is often very large, and it is frequently so mixed with blood as to be distinctly stained by it. There is always some albumin in the urine when pus or blood is present. The albumin is sometimes out of proportion to the amount of blood or pus, even when no serious condition of the kidneys exists.

**Priapism.**—Together with other symptoms of bladder irritation that have been enumerated, we sometimes see erections as another evidence of the irritation caused by the stone, and the consequent congestion of the vesical neck. These are more common in the young, and, in connection with the pulling on the penis to relieve the pain felt in it, may lead to the practice of masturbation.

**Reflex Pains.**—Besides the pain directly caused by the irritation of the stone, there are occasionally distant reflex pains in parts having no close nerve association with the bladder. These pains are distinctly neuralgic in character. They are felt in the hips, thighs, and even run down to the lower leg or foot. Podalgia, pain in the sole of the foot, may be due to vesical irritation from any cause, and may therefore exist as a consequence of stone. These pains, well described by Dr. T. B. Curtis, usually affect the great toe or the ball of the foot. The writer has seen it in the hollow of the instep in a case of prostatic disease. It is described as a burning pain confined to one small spot. Sometimes the feeling is one of intense coldness, or the pain is lancinating in character. These reflex pains, due to bladder irritation, are not confined to the lower extremities, but may be felt through the shoulders and arms.

**Diagnosis.**—There are various conditions of the urinary organs that may produce symptoms closely resembling those of stone in the bladder. Of these may be mentioned inflammatory conditions, tuberculosis, and tumors of the bladder and prostate. Other conditions, such as stricture, chronic inflammation of the urethra, stone or tuberculosis of the kidney, and neuralgia of the neck of the bladder, may produce one or two of the symptoms associated with stone, but do not often give rise to groups of symptoms that are seriously misleading.

The only certain means of settling the diagnosis is by physical examination. This examination may be conducted in a variety of ways:

1. Digital exploration through the rectum or vagina.
2. Exploration with searcher or sound, including examination with a lithotrite.
3. Exploration with a litholapaxy-pump.
4. Examination with a cystoscope.
5. Digital exploration through the dilated urethra in woman, or through a median perineal opening (boutonnière) in man.
6. Digital and ocular examination through suprapubic opening.

This list of manœuvres is arranged in the order of their severity, and usually the information sought will be satisfactorily got by one of the less serious procedures.

1. The examination by the vagina or rectum is that made familiar by gynæcological and other pelvic explorations. With the usual bimanual manipulation a stone may not infrequently be felt and its size correctly judged. This examination is especially applicable to children. Also, during the search with instruments in the bladder, the finger in the rectum or vagina may be of great assistance in locating a stone—as, for instance, one protruding from the opening of a ureter, or a sacculated stone.

2. Exploration with a searcher is the operation familiarly known as "sounding for stone," so called because the instrument used is named a sound, rather than because the ear usually plays any important part in the detection of the calculus; for, although the ear can often catch the click of a sound upon a hard calculus when they are brought sharply together, yet the trained hand will perceive the contact even more sensibly and surely. If the calculus is a small one, or has a soft surface, the touch will often readily recognize the impact of the searcher upon it when no sound can be elicited. The sensations that are perceived through the sound are of two kinds, and are produced by the shock of impact, or by the scratching of the metallic instrument over the rough surface of the stone.

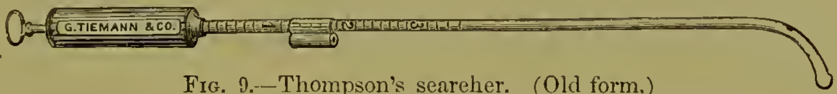

FIG. 9.—Thompson's searcher. (Old form.)

The instrument should have a shape that permits of its easy manipulation in the bladder, and it will be found that a hard metal gives a more distinct sense of contact than a soft one.

The shape of the instrument generally preferred is well shown in the accompanying figures. The shaft should be thin (15 to 18, French scale) for adults, smaller for children. This is in order that the urethra may not hold it firmly, and thus prevent easy rotation and sliding to and fro. The beak may be somewhat larger, and if the end is rounded and blunt it will slide more easily along the urethra. The beak, moreover, should be short, and should form a very moderate obtuse angle (about 120°) with the shaft. An instrument of this shape will rotate readily in the bladder, and will sweep around so close to the vesical face of the prostate that it is not easy for a stone close behind the prostate to evade it.

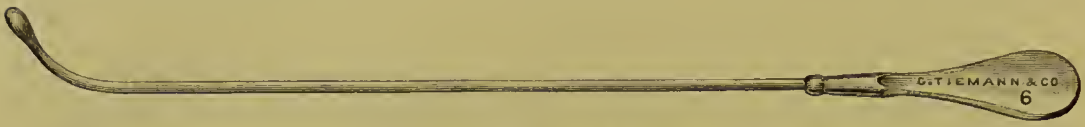

Fig. 10.—Steel searcher.

The handle of the searcher varies in shape according to the fancy of the surgeon; but as much of the manipulation of the instrument is by rotation, a round, barrel-shaped handle, with corrugated surfaces, is perhaps the most convenient; and it should always be marked on the side that corresponds to the point, so that a glance will tell where the beak is directed. A flattened handle, such as is familiar in the urethral sound, is also a good form, and has the advantage that the operator is never for a moment unaware of the direction of the beak. Recognizing the advantage of each of these handles, Thompson has combined them in his latest searcher (Fig. 11).

As it is often desired to change the amount of water in the bladder during a search, the shaft of the instrument may be hollow, like a catheter. This has an additional advantage, that it makes the instrument light, and therefore more susceptible to slight vibrations. The searcher, if hollow, may be made of silver or German silver; or, if solid, of zinc, aluminum, or steel. It has been suggested that a soft metal of high polish would show the scratches of the stone, but it would be indeed a clumsy hand that did not feel a contact slighter than that necessary to mark metal. The softer metals (zinc and aluminum) have the advantage that they can be bent to a special shape for a particular case; they transmit vibrations, however, somewhat less rapidly. A steel searcher in the shape of Fig. 10 is a very delicate instrument, and especially useful in searching children where the urethra is small.

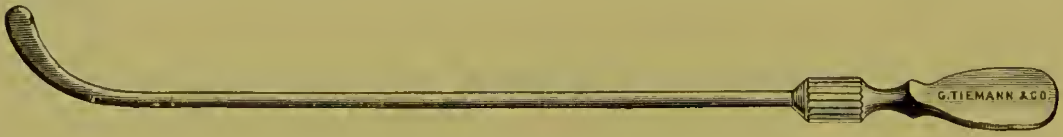

Fig. 11.—Thompson's searcher. (Latest form.)

**The Operation of Sounding** should be conducted with the patient in a horizontal position. In old men, where there is presumably a pouch behind the prostate, the hips may with advantage be raised higher than the shoulders, to roll the stone back toward the fundus.

The question of anæsthesia for sounding must be decided in each case for itself. In children who are restless, hard to control, and whose bladders are so sensitive that they ordinarily empty themselves on the entrance of the instrument, anæsthesia is always to be used when possible. In adults, unless there is unusual sensitiveness, sounding may be accomplished without anæsthesia, or, where thought desirable, the use of a five-per-cent solution of cocaine in the prostate and bladder may be employed. If, however, there is much rigidity in the deep urethra, or spasm of the bladder, interfering with the manipulation of the instrument, the search will be very imperfect and unsatisfactory without general anæsthesia. In case this is used, it is well to make preparation for the immediate removal of the stone, if found. In this way the shock of two sittings of anæsthesia and instrumentation is avoided. Indeed, the chance of serious reaction following an ordinary sounding is so great, that it has been my habit, in cases of old men with large prostates, and with symptoms strongly suggesting stone, to make the first examination with anæsthesia, and with all preparations for operation. I have never regretted this course, for in such cases I do not regard the search without ether as satisfactory, and I have on several occasions found stones under anæsthesia which had eluded me without. This being the case, I feel that it is better to spare the patient the pain and shock of a preliminary examination, and to resort to ether at once.

To proceed now with the method of conducting the search. It is well that the bladder should be moderately distended with fluid, to permit the ready manipulation of instruments within it, and to preclude the possibility of the stone being concealed within its folds when collapsed. The patient being in position, the searcher is carefully introduced through the urethra. The similarity of its shape to that of the lithotrite makes the introduction of the searcher very like that of the larger instrument, and the manipulation will be fully described in the consideration of lithotrity.

The instrument, being in the bladder, is carried down to the most dependent part toward the fundus, and here the stone is usually found. If it is not at once touched, the searcher is to be rotated first to one side and then to the other, so far that its beak comes down against the floor of the bladder. It is then to be drawn forward a little and again rotated from side to side, and so on; little by little the floor of the bladder is investigated, till the beak comes up against the face of the prostate. In cases of enlarged prostate it is here to be completely rotated, so that the point sweeps through the post-prostatic pouch. If the point catches during this rotation, the handle of the searcher should be depressed between the thighs, until the beak is lifted clear of the floor of the bladder. If the stone is still not touched, the lateral portions of the bladder are to be searched by carrying the instrument along first one side and then the other, tapping along the bladder wall on each side. In examining the sides of the bladder, the handle of the searcher should be carried close to the opposite leg.

The upper walls of the bladder may be searched by carrying the instrument well into the viscus and then depressing the handle between the thighs, and, with the point on the roof, rotating it gently from side to side.

Finally, if the search is still unsuccessful, the bladder may be emptied, and, as it collapses, the stone may be brought down against the instrument. Keyes recommends that this final manœuvre be performed with the patient in the upright position, leaning slightly forward. As the water runs out, the beak of the searcher should be kept near the neck of the bladder and gently rotated from side to side. He says that in this way a stone is rarely missed.

**Sources of Error in Sounding.**—It so often happens that a stone is missed by what seems a thorough search, that a moment's consideration of the sources of error is worth while.

*a.* The searcher may not enter the bladder. It sometimes happens, in cases of enlarged prostate, that the sound, after getting into the prostatic urethra, has a considerable degree of mobility, and when the third lobe of the prostate is somewhat enlarged, so as to considerably resist the further passage of the instrument, it is not infrequently thought that the sound is in a contracted bladder. This mistake is much less likely to occur in an examination under ether.

*b.* A light stone, of a specific gravity very close to that of the urine, may give too little shock of contact to be perceived by the sound.

*c.* A stone may be so enveloped in mucus or blood that the sound can not be brought in contact with it.

*d.* An encapsulated stone may be out of reach of the searcher. A stone in a pocket on the floor of the bladder may sometimes be lifted, by the finger in the rectum, to a point where the searcher can touch it.

*e.* Sometimes the opposite mistake is made, and it is thought that a stone is felt when none exists. A tumor incrusted with lime-salts may be mistaken for a stone. This may be suspected, if the stone is always felt in a part of the bladder where it would not be kept by gravity. A stone partly projecting from a pocket, and a stone formed upon an ulcerated surface and so adherent to the bladder wall, will give the same sensation ; so that a diagnosis between these conditions may be impossible.

*f.* When a hollow searcher is used, the rush of water into it as it reaches the bladder may give a shock so exactly like the contact with a stone as to deceive the most practiced touch. It once happened to the writer to meet this sensation when introducing a glass catheter into a female bladder, and each time the tube was slipped in and out the sensation was reproduced again and again, exactly as if the end were tapping on a stone. The introduction of a solid sound showed the bladder to be empty.

Some of the above sources of error may be avoided by using a lithotrite for sounding. A stone too light and small to be felt with a searcher, or one enveloped in mucus or blood, may be grasped in the jaws of the lithotrite. When the sounding is done with this instrument, it is possible to tell whether more than one stone exists; for, with one stone held firmly in its jaws, the lithotrite may be used for further search.

When a stone is touched it is generally possible to tell whether its surface is rough or smooth, and something may be learned of its consistence by the sharpness of the ring which the instrument makes against it.

To judge of the size of a stone by the searcher, the beak should be carried beyond it, and then, while in contact with the farther end of it, the position of the meatus on the shaft should be marked. Many searchers have a sliding collar to slip down against the meatus for this purpose. Now the instrument should be withdrawn along the side of the stone, tapping gently against it until the nearer end is reached, and, noting then the distance that the meatus has moved along the shaft, we have a rough measure of one diameter of the calculus. With a lithotrite, or similar instrument, an exact measure may be taken of the stone in several diameters.

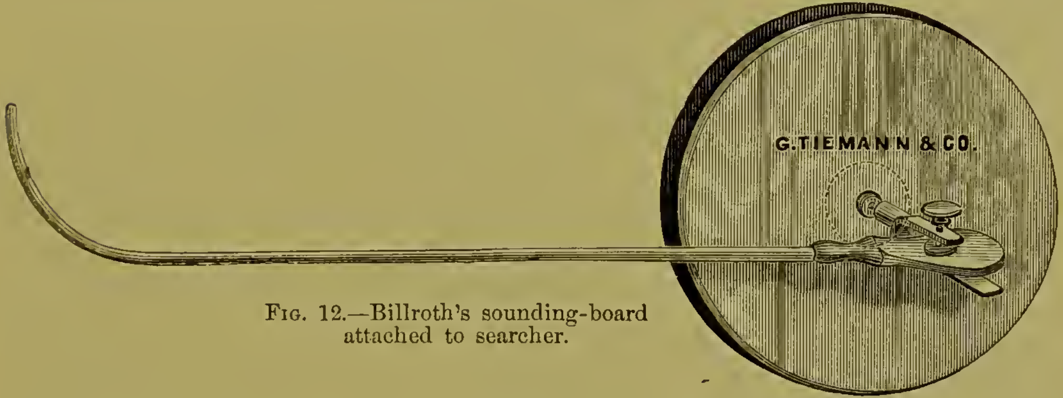

Fig. 12.—Billroth's sounding-board attached to searcher.

Efforts have been made to add to the delicacy of perception by the searcher by the attachment to it of a sounding-board. This is of no assistance to the operator, but may enable him to demonstrate the existence of the stone to the by-standers. Stethoscope-like tubes, connecting the instrument with the ear of the surgeon, are also of no practical assistance.

**Exploration with Litholapaxy-Pump.**—For a small stone, that eludes searcher and lithotrite, Dr. Bigelow showed the evacuating pump to be the best possible sound. The current brings small calculi violently against the orifice of the tube, and the click is both perceived by the hand and heard by the ear. One source of error is to be noted, namely: that sometimes, when the bladder wall is suddenly sucked against the tube, the shock stirs some of the joints of the apparatus, and gives a click very like that produced by the contact of a stone. A mistake from this cause can be avoided by tightening the joints and then prolonging the search without being able to reproduce the sound. If air is contained in the evacuator during the search, its bubbling to and fro may make the perception of a slight click almost impossible.

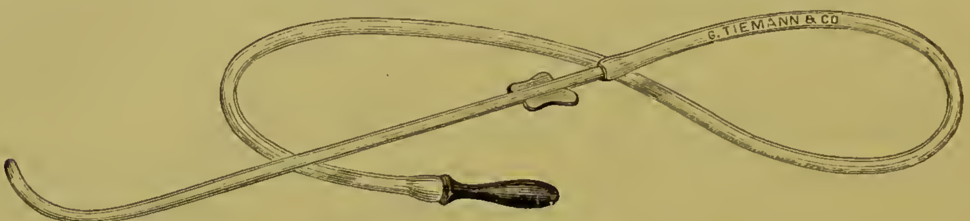

FIG. 13.—Andrew's searcher, with a tube to convey the sound to the ear.

4. **Examination with the Cystoscope** is rarely necessary, as the information sought may be usually obtained by simpler methods.

To decide the diagnosis between an incrusted tumor and an adherent or encysted stone, ocular inspection may be of use. The character of a foreign body serving as the nucleus of a stone might be thus ascertained, though the matter would rarely be in doubt.

5. **Digital Exploration of the Bladder.**—Other kinds of diagnosis failing in cases of suspected stone, a digital exploration of the bladder may be readily made through the dilated urethra in the woman, or through a median, perineal incision with dilatation of the prostatic urethra in the male. In most cases the interior of the bladder can be thoroughly searched in this way. In order that the more distant parts of the viscus may be reached, the bladder should contain no water, but should be collapsed on the end of the finger. Pressure with the other hand into the pelvis is often necessary, in order to bring the upper part of the bladder down on to the examining finger. It occasionally happens in men that the prostate is so much enlarged that the perineal route into the bladder is too long for the ordinary forefinger to satisfactorily reach through it.

6. **Exploration through Suprapubic Openings.**—In cases of doubt, when the bladder can not be reached through the perinæum, a suprapubic opening may be required in order to establish a diagnosis. It will often happen, too, that a high operation may well be chosen in exploration, when there is a strong probability of a condition of things requiring

ready access to the parts for their proper treatment, as in some cases of incrustation of the bladder wall, or of sacculated stone. This matter will be considered at further length under the head of Suprapubic Cystotomy.

**Treatment.**—In approaching the treatment of stone in the bladder, we may consider it under the following heads:

1. Prophylaxis—preventive treatment.
2. Solvent treatment.
3. Operative treatment.

In the care of most cases all these methods will be more or less combined, and the intelligent application of them will do much to relieve the discomforts of the calculous diathesis.

1. **Preventive Treatment.**—The presence of crystals (sand or gravel) in the urine, or the occurrence of renal colic, may give the warning which leads to the adoption of preventive measures. Often, however, this is disregarded, and it is only after the removal of a stone that treatment is instituted to prevent its recurrence.

This treatment will be varied, according to the kind of stone formation which is imminent. If the tendency is to the formation of uric acid or oxalate of lime, the fault is a constitutional one, and must be met by appropriate general measures of treatment. Phosphaturia, too, may be constitutional, and should then be treated generally. Usually, however, alkaline stone formation is secondary, and depends, as has been shown, on some local conditions, which should be met by appropriate local treatment. When a tendency to uric-acid formation is shown, by the appearance of crystals in the urine, or by symptoms indicating a gouty diathesis, efforts should be made to counteract this by a strict attention to the patient's habits in regard to food, drink, and exercise. It was formerly thought that, to prevent the formation of an excess of uric acid, all nitrogenous articles of diet should be avoided as far as possible. Later experience has not fully borne this out, and Lehmann and others have found that a meat diet, unless immoderate, does not increase the excretion of uric acid.

The following rules may well be borne in mind while prescribing for these patients:

It is of the first importance to avoid overeating. In judging of this, the normal requirements of the individual must be sought. These are so various in different subjects that they can only be learned in each person by study and experiment. In each case, too, these requirements vary greatly at different times, and an amount of food which a man may easily bear during a life of active exercise in the summer, will be too much for him in the winter, when shut up indoors and engaged in sedentary occupations.

A relatively light diet should then be adopted, and, while meat is taken, it should not be in excess. This remark applies well to other forms of animal food, such as eggs, fish, etc.

Fatty foods should be used very moderately. It is true that experiments conducted upon a normal individual have shown that butter, up to three ounces a day, does not increase the amount of uric acid excreted. But it must be remembered that people differ greatly in their power of disposing of fat; and while these experiments show that fat in moderation, or even in considerable quantity, does not directly increase the amount of uric acid, they do not show that fat, taken for a considerable time, may not do so by an indirect method. When fat is taken for a long period, especially by a person whose digestion is not vigorous, the presence of the fat among the other food interferes with the digestion of it, and in this way leads to an acid dyspepsia which has a considerable effect in producing uric acid. For this reason many articles of food, which would not be avoided on account of any direct effect in producing uric acid, are to be avoided on account of their influence in producing dyspepsia. Among these may be mentioned pastry, fried articles of food, new bread, etc. Highly seasoned dishes are harmful in two ways: First, they are ordinarily indigestible, and give rise to acid dyspepsia; and, secondly, they stimulate the palate and lead to overindulgence. Sugar and saccharine articles of food are decidedly injurious, and seem to directly increase the excretion of uric acid. They should be wholly given up when there is any appearance of uric acid in the water, and at other times should be used very sparingly by a person of uric-acid tendencies.

Alcoholic drinks should be avoided, as they decidedly increase the excretion of uric aid. Especially is this true in regard to sweet wines and malt liquors, which contain large amounts of saccharine material, in addition to the alcohol. If stimulants are called for in any case, well-diluted spirits, either brandy, whisky, or gin, are to be preferred. Of the wines, the least injurious are very dry champagne, light claret, or thin Rhenish wine.

Systematic exercise is of the greatest importance. This is useful, both by stimulating the digestion and assimilation of food and by furthering the tissue-changes of the body. When possible, the exercise should be violent enough to give rise to a good perspiration, and the skin should be afterward cleared by a vigorous rubbing down. This greatly favors the elimination through the skin, and thus somewhat relieves the kidneys.

Much may be done in reducing the uric acid passed through the kidneys by proper management of the bowels. The influence of a course of treatment at Carlsbad upon a patient of gouty tendencies is well known; and this treatment consists largely in the administration of laxative waters. Much of the benefit ascribed to the waters is, no doubt, more properly to be laid to the credit of the regulation of diet and exercise which is insisted upon, and to which the patient cheerfully conforms, at one of these great sanitaria. Still, the promotion of elimination through the bowels plays undoubtedly an important part.

The sulphates of sodium and magnesium, with which the saline waters are charged, are believed to act upon the liver, as well as upon the smaller intestinal glands, and to be efficacious in removing portal congestion. How much they owe their beneficial effects to their action upon the liver is somewhat problematical, but it is undoubtedly true that they are of great benefit to plethoric patients of constipated habit, with tendency to gout or uric-acid formation.

To be of use, these laxatives should be administered every day in sufficient quantities to insure at least one good, relaxed movement of the bowels. It is not desirable to excite sufficient cathartic effect to cause decided weakness. When this plan is carried out at the patient's home, the Carlsbad salts, Hunyadi Janos, Friedrichshalle, or other similar water, may be administered each morning in the dose that is found to produce the desired effect. It should be taken early on an empty stomach, and usually acts more satisfactorily when warmed or mixed with hot water. If there is evidence of sluggishness of the liver, a three- or five-grain blue-pill may be given occasionally at night, being followed in the morning by the usual saline draught.

The habits of the patient in regard to taking water should also be inquired into. Much water taken at the time of a meal tends to hinder digestion and to favor fermentation and acidity. On the other hand, it is important that sufficient fluid should be taken in the twenty-four hours to keep the solid excreta of the kidneys completely in solution.

When the presence of crystals in the urine shows that the solids are not held in solution, and that the danger of stone formation is imminent, it becomes important to administer some solvent agent which shall as quickly as possible remove the danger. For this purpose the salts of lithia, of potash, or of lithia combined with potash, may usually be depended upon to prevent the further formation of crystals. Piperazine has lately been brought into notice as a powerful solvent. The further consideration of this question will be found under the head of "Solvent Treatment." Probably, however, one of the best ways of getting rid of crystals is by administering large quantities of water, producing a flushing of the urinary tubes and reservoirs, and thus washing them out.

The above remarks concerning the control of uric-acid tendencies may be applied, with but slight variation, to the cases showing a tendency to oxaluria. It is to be remembered, however, that in prescribing the diet of these patients fruits containing oxalic acid should be specially forbidden. I have seen sharp attacks of oxaluria follow indulgence in rhubarb

(*Rheum ponticum*, familiarly known as pie-plant throughout New England). Oranges, strawberries, and tomatoes should be omitted from the dietary while oxalate crystals are present in the urine, and should be used sparingly at all times by patients of oxalic proclivities. Phosphaturia may usually be relieved by the exhibition of nitro-muriatic acid, and its recurrence is to be opposed by hygienic measures, including adequate exercise and a relief from care, if that is possible. General nerve tonics, such as iron, quinine, and strychnine, will sometimes be of distinct benefit. When cystine has been detected in the urine, Beale recommends the use of ammonic carbonate.

As has been said, in considering the etiology of stone, not only the deposition of crystals, but also the presence of albuminoid materials, is necessary for the formation of a calculus. These are usually supplied in the form of mucus, or muco-pus, which is exuded from the walls of the urinary passages in consequence of the irritation of the crystals in the urine. Anything which tends to lessen this irritation will have some effect in hindering the formation of stone, and soothing diuretics may therefore play some part in the direction of prophylaxis.

**Local Treatment directed to the Prevention of Stone.**—Besides these general measures directed to the constitutional conditions that lead to stone formation, much may be done by direct treatment to correct the conditions which locally favor the accumulation of crystals and their concretion into stones.

When the bladder does not completely empty itself, the residual urine should be drawn off from time to time. Even when the tendency is to the deposit of uric-acid crystals, this may prevent their collecting and having time to agglomerate themselves into a nucleus. It is, however, in the prevention of phosphatic stones that the removal of residual urine plays the most important part. It is in a fermenting residuum of urine that the deposition and coalescence of phosphates goes on most rapidly, for the accompanying cystitis liberally supplies the albuminoid skeleton in which the crystals build themselves up into a stone. At such times thorough irrigation, removing crystals and mucus and bringing the fermentation to a stop, may act as a most effective preventive measure.

It may be appropriate to mention here certain drugs which, when administered internally, impart to the urine some antiseptic qualities, and which therefore check fermentation, and also have indirectly a topical effect upon the bladder.

Benzoic acid and the benzoates of soda and ammonia may be given in doses of from 10 to 15 grains, or even, if needed, in much larger quantities. Over 300 grains of the benzoate of soda have been given in a day without unpleasant effects. Under their use the ammoniacal tendencies of the urine are largely corrected. Benzoic acid is eliminated by the kidneys, either unchanged or as hippuric acid. It is, however, not well borne by the stomach, and it is usually preferable to administer one of its salts. These are broken up in the body, and furnish benzoic acid to the urine.

Boracic acid, administered internally, produces a decided antiseptic effect on the urine. It may be given in doses of 10 or 15 grains three or four times a day, either in capsules or in a very dilute solution. It is not well borne by a delicate stomach.

Eucalyptol may be given in an emulsion in doses of from 3 to 5 minims. It is excreted by the kidneys, and imparts its odor, together with its antiseptic properties, to the urine.

Salol, salicylic acid, and the salicylates, have also some antiseptic effect upon the urine. When used for this purpose, the dose should not be pushed to the extent that is usual when they are given as anti-rheumatics. It is a good rule to administer all these antiseptic remedies midway between meals, as, if taken when there is food in the stomach, they are likely to interfere with the digestion of it.

Even after a small concretion has formed in the bladder, or has found its way down from the kidney to the bladder, there are certain manœuvres that assist its passage through the urethra by the natural efforts. Before the operation of litholapaxy was devised, attempts in this direction were of some importance, and patients were advised to drink liberally of water, to hold their urine until the bladder was distended to its full capacity, and then in passing water to assume a position slightly bent forward, so as to bring the urethral opening into the most dependent part of the bladder, so that the stone should rest over or close to it, and be carried into the canal by the first rush of the stream.

This plan, when successful, subjects the patient to the risk of impaction of the stone in the urethra, and a small concretion can be pumped out so readily with a litholapaxy-bulb, that it is unwise to waste time with less efficient methods.

**Solvent Treatment of Stone.**—Although experience has given but little encouragement to those who have attempted to bring about the solution of stones in the bladder, still their efforts have brought out interesting facts, and are worthy of a moment's attention. In these experiments the solvent fluid has been brought in contact with the stone in one of two ways: either (1) the urine has been so changed by the administration of drugs as to itself become a solvent fluid, or (2) the dissolving agent has been injected directly into the bladder.

Before considering what has been accomplished in these attempts, let us look a moment at the conditions under which the work must be done. In the preceding pages we have spoken of the different methods of bringing about the solution of free crystals in the urine; but when we approach the question of the possible solution of stones already formed, we find the situation a more complicated one.

In the first place, a stone presents a comparatively small surface upon which the solvent can act. This surface is to a considerable extent protected by the mucus which adheres to it. Even if the outer layer of calcareous matter could be dissolved, this would leave the stone covered by a tenacious albuminoid envelope, which would serve as a protection against the further action of the solvent. Moreover, stones are not usually made up of one kind of earthy salt, so that the agent designed to dissolve one constituent of the calculus would have no action upon the others in it.

Besides these obstacles offered by the stone itself, the sensitiveness and delicacy of the bladder introduce a difficulty hitherto insuperable. For no fluid has been discovered which can be used in a sufficient concentration to have any powerful solvent effect on the stone without being dangerously irritating to the urinary organs.

(1) Efforts to dissolve stone by the administration of drugs which shall act through the urine date back at least to the time of Pliny. He speaks of burned snail-shell as a remedy for stone, and from that time to this the mixtures that have obtained any popular repute have usually contained alkalies, either potash, lime, or soda in some form. Probably these, as well as the vegetable diuretics and mineral waters, obtained their reputation largely from their soothing properties rather than from any solvent action; and it seems fair to suppose that the cases which made them celebrated for a time were often instances of bladder inflammation without stone.

The early essays at stone solution have not left any accurate data from which to draw conclusions as to their efficiency. Recently this subject has received some attention, and has been investigated in a more thoroughly scientific manner. Roberts (Treatise on Urinary and Renal Diseases, fourth American edition, 1885, pages 315–334), who has made a careful study of the subject, believed that his results, while not indicating the general possibility of substituting a solvent for a mechanical treatment of vesical stone, suggested essential improvements in the treatment of renal calculi.

Each form of calculus has to be considered separately. Taking first the more common uric-acid calculi, Roberts started his investigations by accepting two propositions as already proved: First, that solutions of the alkaline carbonates exercise a solvent action on uric acid; second, that urine can be rendered alkaline from alkaline carbonates by the administration of certain salts by the mouth. Examining now the comparative solvent powers of the various salts, he found that outside of the body carbonate of potash was decidedly more solvent than carbonate of soda; also, that a solution of from 40 to 50 grains of the carbonate to the pint gave better results than one either weaker or stronger than this; also, that the quantity of the solution allowed to flow over the stone in twenty-four hours made but little difference in its daily loss in weight. The rate of solution obtained by fluids of the maximum solvent power he found to be from ten to twenty per cent of the calculi in the course of twenty-four hours.

Encouraged by these results, he next turned his attention to finding the best way of alkalizing the urine to the strength which he had found best in his experiments outside the body. He found that by administering from 40 to 50 grains of the acetate or citrate of potash every three hours he obtained an average alkalization equal to about 50 grains of the carbonate to the pint. With urine thus rendered alkaline he experimented upon uric-acid calculi outside of the body, and found that they underwent solution at the mean rate of 12½ grains in twenty-four hours. If, however, the urine became ammoniacal, it was found that the calculus became covered with a crust of mixed phosphates, which protected it from any further solvent action. This points to the practical importance of avoiding any alkaline fermentation of the urine while applying alkaline treatment.

These experiments are interesting as showing that the alkalies thus administered have decided solvent powers. Later observations by Garrod and others have seemed to show that the lithia salts have even more power in rendering uric acid soluble, and they have also found that lithia is well borne by the stomach. Garrod speaks of slight muscular tremors as occasionally produced by large doses of lithia salts. These have been met with by the writer, but have never caused serious inconvenience, and are only to be taken as a warning of the need of a cessation of the medicine for a time.

Another substance that has claimed some attention as a solvent of uric acid is piperazine. It is said to dissolve, in cold solution, twelve times as much uric acid as carbonate of lithia. Vogt thought that the amount of urea increased and uric acid diminished under its use, but these observations have not been verified by other investigators (Modern Materia Medica; Helbing, London, 1891). Biesenthal and Schmidt (Berliner klin. Wochenschrift, No. 2, 1892), from clinical and experimental researches, attest its value as a solvent of uric acid in the system, and have found that it increases the elimination of it.

It should be given dissolved in water, in a daily dose of 15 grains. They also recommend its use in a one to two per cent solution, as an irrigating fluid in the bladder, for the solution of calculi. It is asserted also that it dissolves the albuminous substances that hold concretions together, and so, it is thought, may be useful as a solvent of mixed stones, containing other salts besides uric acid or the urates.

Oxalate of lime and phosphatic stones have proved quite intractable to the action of solvent remedies administered by the mouth.

Cystine is, according to Roberts, quite soluble outside the body in a solution of carbonate of potash, 40 grains to the pint. He found, however, clinically, that urine rendered alkaline by potash salts had little or no solvent power, and even contained crystals of cystine floating in it. Beale (London Lancet, August 30, 1884) has found that large doses of carbonate of ammonia have the power of causing cystine to disappear from the urine. One hundred and fifty grains a day was the quantity taken by one of his patients.

(2) The solution of stone by agents injected into the bladder has not succeeded to an encouraging degree. As the retention of injections in the bladder can not be prolonged over any considerable length of time, the solvent strength of the injected fluid must be very great in order that anything may be accomplished by this method. Practically, however, strong solutions are not borne by the bladder. The most successful application of this method is seen in the solution of phosphates by the injection of diluted nitric acid. This proceeding, suggested and carried out by Sir Benjamin Brodie, is no doubt available against small bits of phosphatic material, and very probably the astringent and stimulating action of the nitric acid improves the condition of the bladder, and thus helps to prevent the recurrence of phosphatic deposition. There are, however, no observations to show that stones of any considerable size can be thus disposed of.

Finally, attempts have been made to aid in the solution of stones by the electrolytic action of the galvanic current. Some slight effect was produced in this manner on stones outside of the body, but all attempts to make the process of use have been found unsuccessful, both on account of the time required in the manipulation, and because the stones proved unexpectedly resistant, owing to unlooked-for qualities in their composition; for stones composed of but one constituent were found to be not suited to electrolytic action.

The recent improvements in operative procedures for the removal of stones make the mechanical treatment so sure and easy that there is little inducement to try any of these tedious methods of solvent treatment in ordinary cases. Under exceptional circumstances, when operative treatment seems contra-indicated, they may occasionally be of service. Their legitimate field of action is in the treatment of stones in the kidneys, which can only be reached surgically by more dangerous operative measures.

## THE OPERATIVE TREATMENT OF STONE.

**History.**—Operations for the removal of stone in the bladder have always occupied a large share of surgical attention. The history of this subject has been so often and thoroughly written that it is not intended here to treat it exhaustively, but only to trace broadly the evolution which has led up to the present methods, and to dwell for a moment on the changes which have marked eras in the progress of this branch of operative surgery.

Before the present century the only operations practiced for the removal of stones were by cutting. It is true that in the early Arab writings the idea is advanced of wearing down a calculus by the friction of a diamond fixed on a wire, and thus introduced into the bladder along the urethra, and that other equally inefficient plans for rubbing down a stone were thought of in somewhat later times. The imperfection of instruments and methods in those early days prevented, however, these operations from obtaining a foothold among the accepted procedures of surgery.

The cutting operations for the removal of stone may be divided into two classes: first, those performed through the perinæum; and, second, those done above the pubes—high or suprapubic operation.

The perineal operations are by far the most ancient, dating back at least to the beginning of the Christian era; while the suprapubic operation originated with Pierre Franco, in 1560. The earliest operations through the perinæum were done without a guide. The first authentic and detailed report of these is given us by Celsus, of the school of Alexandria. It appears that the operation, as practiced, had come down from antiquity without special rules, the technique being passed on from one operator to another. In the operation described by Celsus, the stone was pulled downward by the fingers in the rectum, and was then cut down upon through the perinæum. The incision employed appears to have been either transverse, bilateral, or lateral, and the bladder was entered either through its body or its neck, according to accident. This is the method known as "cutting on the gripe," the *apparatus minor*—so called because but few instruments were required.

Eginus, describing what is practically the same operation, says that the external incision should be made on the side of the perinæum toward the left buttock. The intention was that the incision into the bladder should be made through the neck and not through the body of the organ; for it was thought that a wound of the wall was not likely to heal satisfactorily.

According to Celsus, only children from nine to fourteen were suitable subjects for the operation. Eginus speaks of it as applied to all ages.

A variation of the perineal operation without a guide, consisted in plunging a grooved director into the bladder through the ischio-rectal fossa, and then passing the blade of a bistoury along the groove and with it making an incision of the required length. This operation was so dangerous as never to come into good repute.

After these early descriptions, surgical literature is for a long time silent in regard to lithotomy—a fact which suggests that it was not accepted by the authorities, but was relegated to specialists and empiries. It was not until 1533 that any movement in the direction of better methods was made. In this year Marianus published a description of the operation known under the name of the *apparatus major*, on account of the large number of instruments which it required. This operation was not original with him, but his description is the first reliable one that we have of it. It was a distinct advance over the operation of "cutting on the gripe," in that a grooved staff passed through the urethra was used as a guide, and gave the operation much greater precision. The operation of Marianus consisted in a median incision, opening the deep portion of the urethra, through which the neck of the bladder was stretched either by a two-branched dilator, or by the introduction of a gorget. It was practically the operation now known as the "*boutonnière*," and differed from the present median operation in the fact that the prostate was not incised. While a far safer operation than those which went before it, it was very unsatisfactory for the removal of large stones. This was the operation practiced by Franco, who modified it somewhat, and added to it the use of a concealed bistoury for incision of the prostate.

While the perineal operation was in this stage of its development, Franco was led by an accident to adopt the incision above the pubes, and thus became the inventor of the suprapubic operation, of which, however, he did not recognize the value.

At the beginning of the eighteenth century, Jacques Baulieu, better known as Frère Jacques, operated in Paris in a manner which he had learned from an itinerant lithotomist. In this operation the incision through the perinæum was made on the left side, and the operation was done upon a staff in the urethra. Curiously enough, Frère Jacques at first employed a round staff for his guide, and it was only after this had been adversely criticised that he adopted the grooved staff which had so long been in use for the median operation. With his method thus improved, he obtained many satisfactory results, and, with further modifications by Cheselden, the modern *lateral operation* was brought to perfection.

During the eighteenth century and the early part of the nineteenth, under the stimulus of success which now attended the operative treatment of stone, many surgeons sought to further improve existing methods and to discover still safer routes into the bladder. Frère Côme introduced the use of a concealed bistoury in the lateral operation, with the object of gaining mathematical exactitude for the deep incision. The cutting gorget was also used for the purpose of exactly limiting the incision in the prostate, and the blunt gorget was introduced to dilate the deep incision. These instruments were made in various shapes, and were much recommended by their inventors; but to-day most surgeons use the scalpel for the whole incision in the lateral operation, and it is rare that a lithotome or gorget finds its place in a modern armamentarium.

In the search for better incisions, the notable modifications devised were the *bilateral operation*, published by Dupuytren, in which a semilunar incision with its concavity backward was made transversely across the perinæum, and the prostate was incised with a double lithotome. The *medio-bilateral*, Civiale's modification of Dupuytren's operation, differed from it in that the incision through the skin was on the median line, while the incision in the neck of the bladder was bilateral. The *recto-vesical* operation consisted in a median incision through the anterior margin of the anus and anterior rectal wall, and so into the bladder, either through the prostate or through the trigone just behind it. The mortality of this operation, and the frequency of troublesome fistulæ which followed it, prevented its general adoption. None of these variations have proved to be of any especial value, and the median and lateral operations still hold their places as the best perineal methods.

While perineal lithotomy was passing through this gradual evolution, the suprapubic or high operation had various periods of favor and discredit. It proved its value for the removal of large stones, but showed itself to be much more dangerous than the perineal operations, and so did not succeed in displacing them for the majority of cases. Later, however, in 1878, as will be described in the chapter on Lithotomy, such improvements were made in the technique of the high operation, that it has now to a considerable extent displaced the operation through the perinæum.

In 1824 the first serious effort was made to remove stones through the natural passages by pulverizing them in the bladder with instruments introduced through the urethra. In that year Civiale operated publicly with a three-branched instrument which he had devised some years before, and successfully crushed a small stone, fragments being passed by the natural efforts. Even with his imperfect instruments Civiale produced results which showed the possibility of treating stone in this way.

This opened a new era in the treatment of stone, and immediately the mechanical ingenuity of surgeons and instrument-makers was taxed to the utmost to devise new and more efficient lithotrites. The gradual evolution of these instruments will be traced in the discussion of lithotrity.

Finally, in 1878, Bigelow showed that it was possible to combine thorough crushing and complete evacuation of the fragments in one operation. With this well-proved method it is now possible to quickly remove large stones from the bladder through the natural passages, without any serious injury of the soft parts—an almost ideal result.

After this brief glance at the history of their development, we will proceed to an examination of those methods of operation which have survived. In determining the comparative merits and applicability of the various operations for stone, it is evident that only statistics of recent date can be relied upon for forming an idea as to the comparative mortality of different methods. The general adoption of antiseptic precautions has so greatly diminished the dangers of all cutting operations, that the old rates of mortality can no longer be depended upon in estimating the dangers of modern lithotomy. It would be impossible to reflect the opinions of all the recent writers upon the subject as to the present standing of the various operations for stone removal, but we will attempt, in the description of the various operations, to give to all a fair consideration of their merits, and to consider the special conditions under which each one is applicable.

## CHOICE OF OPERATION.

Before proceeding to the separate examination of the various operations, let us look for a moment at the considerations that are to be taken into account in deciding upon the operation proper to a given case; for the surgeon who best appreciates the influence which varying conditions should have upon his choice of procedure, and who decides each case for itself, selecting the operation which most surely avoids the dangers surrounding that particular patient, will arrive at better results than the advocate of a special operation, however expert.

The question of comparative danger is not the only one that the surgeon has to take into account in choosing an operation. He must also have regard to the interference with bodily functions which the various operations entail; and, lastly, he must decide as to the probable completeness of cure which he can obtain by one or another method.

First, in regard to *the comparative danger of the different operations.* A glance at the rates of mortality shows us at once that we can not properly compare the results in patients of very different ages. The mortality of children and young adults after any operation upon the bladder is distinctly less than it is in advanced life, and there are at different ages changes in the organs concerned which make marked differences in the manner in which the various measures are borne. For the sake of convenience in this study, cases may be grouped in three categories:

Children, from birth to fourteen years of age.
Adults, from fourteen to fifty.
Old men, from fifty upward.

This division of cases is somewhat arbitrary, but the ages of fourteen and fifty are selected as marking, more or less accurately, certain epochs in the development and decay of the genito-urinary organs. At about fourteen we look for changes in the size and sensibility of these organs, which accompany the arrival of puberty; and at fifty senile changes in the bladder and prostate begin to make their appearance, which often interfere with the healthy performance of the functions of those parts. In the collection of statistics, those tables only should be used in which the operators have published all their results, and reports of single cases should not be included. This is to avoid the danger of forming tables of exceptional results, for single cases are more likely to be reported when successful than when they resulted unfavorably.

As I have been unable to find any ready-made statistics showing the comparative results of the different modern methods of operation, I have collected a series of cases from accessible published reports, and from the private reports of unpublished cases which I have been able to obtain in the time at my command. I have succeeded in obtaining 2,562 cases in which the ages of the patients were given, so that they could be classified in the manner above indicated.

All these cases have been operated upon since 1878, and have thus occurred during the time when they would have all the advantages of modern surgical methods.

**Perineal Lithotomy.**—This operation has not shown any modern improvement in technique beyond the introduction of aseptic methods. A comparison of results under old and new methods is interesting.

Keyes, in an article on Urinary Calculus, contributed by him to the International Encyclopædia of Surgery, gives the following table, which contains the death-rate calculated by Coulson from an analysis of 2,972 cases, and by Thompson from an analysis of 1,827 cases:

| Age. | Death-rate, Coulson. | Death-rate, Thompson. |
|---|---|---|
| From 1 to 10 years | 1 to 13·08 | 1 to about 18·91 |
| “ 11 to 20 “ | 1 to 10·28 | 1 “ 8·25 |
| “ 21 to 30 “ | 1 to 6·61 | 1 “ 4·00 |
| “ 31 to 40 “ | 1 to 5·83 | 1 “ 10·50 |
| “ 41 to 50 “ | 1 to 4·50 | 1 “ 6·00 |
| “ 51 to 60 “ | 1 to 3·65 | 1 “ 4·75 |
| “ 61 to 70 “ | 1 to 3·23 | 1 “ 3·75 |
| “ 71 to 80 “ | 1 to 2·71 | 1 “ 3·16 |

Thompson's cases may owe part of their improvement in results to the commencement of antiseptic habits in surgery. Better methods of handling the stone, of controlling hæmórrhage, and of conducting the after-treatment, are, however, mainly responsible for the lower death-rate.

I have collected 764 cases of perineal lithotomy. They resulted as follows:

| | | | | | | |
|---|---|---|---|---|---|---|
| Children under 14, | 539, | with | 16 | deaths; | 2·96 | per cent of mortality. |
| Adults, 14 to 50, | 177 | " | 19 | " | 11·30 | " " |
| Old men, | 48 | " | 8 | " | 16·66 | " " |

The number of operations upon old men is too few to give a reliable percentage of mortality. The operation is probably more dangerous in old age than is here indicated.

Freyer gives the following rates of mortality after lateral lithotomy, arranged according to age. They are calculated from 987 cases occurring during the year 1883 in the Northwest Provinces of India:

| | |
|---|---|
| Rate of mortality up to 20 years | 5·1 per cent. |
| " " from 20 to 40 years | 10·7 " |
| " " above 40 years | 31·9 " |

Rosenthal, from a collection of 400 cases, deduces the following rates:

| | |
|---|---|
| Mortality from 1 to 15 years | 3·5 per cent. |
| " " 6 to 11 " | 2·1 " |
| " " 12 to 16 " | 8·4 " |
| " " 17 to 29 " | 15·7 " |
| " " 30 to 66 " | 38·8 " |

Harrison, from more than 100 cases, taken irrespective of age, gets a mortality rate of 1 in 12.

Keyes says that his "perineal lithotomies before puberty have been few in number, and have all recovered." In those cases after puberty he has found "the mortality much higher than for the crushing operation."

**Suprapubic Lithotomy.**—I have obtained data of 744 cases of this operation, from which the following table has been made:

| | | | | | | |
|---|---|---|---|---|---|---|
| Children under 14, | 591, | with | 74 | deaths; | 12·52 | per cent of mortality. |
| Adults, 14 to 50, | 100 | " | 12 | " | 12·00 | " " |
| Old men, | 53 | " | 17 | " | 32·07 | " " |

Comparing these with other statistics, the results in children and adults are more than usually favorable.

Garcin, from a collection of 106 cases of all ages, calculates a death-rate of 24·4 per cent. Tuffier, from 120 cases without regard to age, has a death-rate of 27 per cent. Dulles, among 231 adults, finds a mortality of 32·4 per cent; while among 132 children there was a death-rate of 21 per cent.

Besides the cases tabulated above, I have obtained reports of 165 cases, unclassified as to age, in which the death-rate was 15·15 per cent.

**Litholapaxy.**—I have classified reports of 1,074 cases of litholapaxy, as follows:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Children under 14, | 241, | with | 4 | deaths; | 1·66 | per cent | of mortality. |
| Adults, 14 to 50, | 400 | " | 13 | " | 3·25 | " | " |
| Old men, | 433 | " | 26 | " | 6·00 | " | " |

Guyon had a mortality of 5·2 per cent in 647 cases of all ages. Usigli calculates a mortality of 4 per cent, while Tuffier places it at only 3 per cent.

Keyes, in 100 cases, lost 7, but almost all his patients were old men, many of them with desperate disease of the urinary tract, and even under these unfavorable conditions the later cases are showing better results.

From these statistics we see that in childhood, judging from the results as to mortality, there is little to choose between lateral lithotomy and litholapaxy, the advantage, however, being slightly with the latter. Suprapubic lithotomy is more dangerous, with a death-rate of about 12 per cent.

In adult life the death-rates alter very decidedly in favor of litholapaxy. As the prostate and urethra enlarge, and the parts about the neck of the bladder become more vascular, the dangers incident to cutting through them increase. On the other hand, the increase in the size of the parts makes the performance of litholapaxy comparatively easy and safe. Suprapubic lithotomy keeps its place as a more dangerous operation than either. In old age, the rates of mortality are overwhelmingly in favor of litholapaxy. While the dangers attending all the cutting operations have increased very greatly, the mortality after crushing is very little higher than it was earlier in life.

## INTERFERENCE WITH THE FUNCTIONS OF THE PARTS.

It is somewhat exceptional to see a serious loss of function follow any of the operations for the removal of stone. The parts are more injured by some of the operations than by others, but usually the restoration of function is satisfactory, if not complete.

A *litholapaxy*, carefully performed, should never cause any lasting injury of the genito-urinary organs. It may sometimes happen, in an old man with an enlarged prostate, that the instrumentation so irritates the neck of the bladder as to lead to a still further swelling of the prostate and thus causes retention, which may subsequently require systematic catheterization. This course of events is only likely to occur in patients who had already a partial retention, with loss of expulsive power in the bladder, who were therefore close to the time when they would require the constant use of the catheter in any event.

The *suprapubic incision* does not traverse important parts, and therefore rarely causes after-trouble. Occasionally a fistulous opening remains which can not be closed, and therefore is a source of discomfort to the patient; but this accident can usually be avoided by the timely removal of the drainage tube.

The *perineal operations*, entering, as they do, through the neck of the bladder, are more likely to cause serious trouble. The seminal ducts, situated in the lower part of the prostate, are exposed to injury by incisions in the floor of the prostatic urethra, and impotence from this cause is to be feared. The median operation avoids this when the stone is small enough to be removed by stretching the neck of the bladder, but even then lacerations are likely to occur. The lateral incision has the advantage that, while giving more room, it endangers only one of the ducts. The erectile tissue, known as the caput gallinaginis, is also liable to injury by perineal incisions, and this, too, may lead to sterility. I have seen a man who was cut by the lateral method when a child, whose semen escaped into the bladder during coition, and was afterward passed with the urine. This seemed to be due to the failure of the erectile tissue to close the neck of the bladder behind the ejaculatory ducts.

Incontinence of urine is another occasional result of perineal operations. Both sphincters of the bladder are often completely divided, and, although the restoration of function is usually complete, it sometimes happens that the healing is in some way interfered with, and a permanent loss of retentive power is the result. Persistent fistula following perineal lithotomy is not very uncommon. Werewkin records this as occurring seven times in 147 cases of lateral lithotomy in children.

It is claimed that stricture does not result from this operation, but the writer has met with a decided narrowing in the membranous urethra in two cases. One of these was a man who had been cut in childhood, and had been subsequently subject to attacks of cystitis. The membranous urethra was narrowed to No. 25 French, while the rest of the canal would admit a 31 French sound. The other case was a child in whom the persistence of a perineal fistula led to an examination of the urethra, and a decided narrowing was found at the junction of the bulbous and membranous portions of the canal.

Injuries of the rectum during lateral lithotomy are accidental and unnecessary; still, they happen often enough in the hands of expert operators to make it worth while to take this possibility into account in deciding upon an operation.

It would not be proper to close this consideration of the chances of a loss of function after these operations without calling to mind the fact that some of these methods open the way for a restoration of function by allowing opportunity for the removal of obstructing portions of the prostate, and thus tending to the recovery of the power of urination. This is especially true of the suprapubic operation.

## COMPLETENESS OF CURE FOLLOWING THE DIFFERENT METHODS OF OPERATING.

It is a not uncommon experience to see a second or third attack of stone in the same patient. In order to understand how far this reappearance of a calculus is dependent upon the operation by which its predecessor was removed, let us consider the ways in which a recurrence of stone may come about:

1. A uric-acid stone may be followed by another on account of the persistence or reappearance of the uric-acid diathesis. This may be true, though less commonly, in the case of an oxalic stone, and may even occur with a phosphatic stone due to phosphaturia of constitutional origin. When cystine is present in the urine, the frequent appearance of small calculi is a characteristic feature of the disease.

2. The successive escape of several stones from the kidneys may give rise to consecutive attacks of stone in the bladder. These stones may be uric, oxalic, phosphatic, or composed of cystine.

3. A soft, phosphatic stone may be reproduced after removal, if the chronic cystitis and alkaline condition of the urine, which led to the original formation, persist. This is not uncommonly seen in those cases where an obstruction to the complete emptying of the bladder perpetuates the fermentation of the urine.

4. Lastly, if a fragment is left after operation it may serve as the nucleus for another stone. The danger of this mischance is greatly increased by any obstruction to the flow of the urine, such as is caused by an enlarged prostate. The bladder in such cases is often sacculated, so that fragments are more likely to escape removal by the evacuator after litholapaxy, or by the lithotomy scoop and forceps after lithotomy; and if such a fragment be left, it is very unlikely to be voided by the natural efforts of the bladder, but remains in the residual urine. A healthy bladder that completely expels the urine at each act of micturition usually frees itself from such small fragments.

It is plain that recurrences due to the patient's diathesis, in which a new stone forms years after the removal of a former one, can not be laid at the door of the operation, being as likely to follow one method of removal as another. And the same is true when successive escapes of renal calculi from the kidneys give rise to recurrent attacks of stone. In cases where a recurrence is due to a persistent cystitis, with consequent deposition of phosphatic material, the later attacks of stone can not be ascribed to incompleteness in the operation, but rather to neglect in the after-treatment. It is obvious that, to prevent this sort of recurrence, it is important to entirely relieve the cystitis before allowing the patient to pass from under observation, and then to send him away with a clear understanding of the importance of immediately correcting any tendency to alkalinity of the urine or to pus-formation. (See PREVENTIVE TREATMENT OF STONE.)

Finally, a stone which has for its nucleus a fragment of an earlier stone, is obviously the result of an incomplete operation, and no method can be regarded as satisfactory which is often followed by such recurrences.

It has been charged against litholapaxy that this accident of the retention of a fragment is very likely to follow it. The means of preventing this will be considered at length in the description of that operation; and suffice it here to say, that since the possibility of this occurrence has been generally recognized, the measures taken against it have been almost uniformly successful in preventing it. Moreover, it is an accident by no means confined to this operation. It is not uncommon to have stones broken, or fragments chipped off of them by the lithotomy-forceps, and, as may be supposed, this is more apt to occur in perineal lithotomy, where the stone has to be dragged through a narrow wound, than in the suprapubic operation, where more space is offered. Fragments so left are often very difficult of removal with the scoop, or by irrigation, and instances of their retention after lithotomy, and of subsequent stone formation about them, are not infrequently reported.

## SELECTION OF OPERATION.

From what has been said above, it will be seen that many matters have to be taken into consideration in making the proper choice of operation in each case. Indeed, much of our knowledge in regard to the treatment of stone is so new that we are only now accumulating the data on which our judgment must be based.

*In childhood*, as has been shown, the mortality after any operation for stone is small. Lateral lithotomy and litholapaxy are very nearly equal in this respect, and both are decidedly safer than suprapubic lithotomy. The crushing operation has the great advantage that it avoids injury to the seminal ducts and rectum; also, that it does not give rise to fistula or to the incontinence of urine—all of which are occasional results of perineal lithotomy. An ample experience has shown that the urethra and bladder of a child will tolerate a considerable amount of instrumentation. It would therefore seem wise to use litholapaxy for all small stones, or stones of moderate size (from one and a half to two and a half centimetres in diameter), and for stones larger than this to do lateral lithotomy, except when they are very large (three and a half centimetres and upward in diameter), and then suprapubic cystotomy is to be resorted to.

The ease with which bimanual palpation can be practiced in children, with the finger in the rectum and a hand on the abdomen, makes it possible to judge pretty closely the size of the stone, and so select intelligently the best method for its removal. The consistency of a stone is also to be taken into account when litholapaxy is to be thought of, and stones of considerably larger size than is above indicated may be crushed, if they are soft and friable. The quality of a stone in these regards may usually be determined with some degree of accuracy by the sensation imparted to the sound and by a knowledge of its probable constituents, which can often be gained by an examination of the urine. Certain other conditions which should lead us to employ some other method than litholapaxy will be spoken of in considering the operation in adults.

Whether we consider the danger of the various operations for stone in the adult, or the likelihood of the disturbance of functions following them, we are led to regard *litholapaxy* as the operation of choice for stone removal. With the efficient lithotrites and evacuator which make "lithotrity at one sitting" possible, it is now usual to remove stones of considerable size and hardness, and practically it has been found that, under ordinary conditions in adults, any stone which is suitable for lateral or perineal lithotomy is suitable for litholapaxy, and that even stones so large that they would require a suprapubic incision if they were removed with the knife, may, when reasonably friable, be pumped out. A number of instances are on record in which stones between 2,000 and 3,000 grains in weight have been successfully removed in this manner.

The exceptional cases in which litholapaxy can not be used are as follows:

1. A very large and hard stone may resist every attempt at crushing, especially if it is tightly grasped by the spasmodically contracted bladder.
2. A stone may have as a nucleus a foreign body, such as a bit of necrosed bone, or a bullet, too hard to crush and too large to pass out through a tube.
3. An encysted stone may be out of reach of the lithotrite.
4. Some writers hold that stricture of the urethra may prohibit litholapaxy. This can not often happen, for strictures, however close, yield readily to divulsion, which may be immediately followed by the crushing and evacuation of the stone. I have so often seen these operations successfully done on an etherized patient, that I can not but think this the best practice. While it economizes time, it saves the patient much needless manipulation.
5. False passages may exist, which interfere with the introduction of instruments, so that the dangers of the operation are greatly enhanced, and the question of lithotomy is to be entertained.
6. The hip may be anchylosed in a position which interferes with the use of urethral instruments.
7. A stone may be so lodged in the entrance to the urethra that it

can not be pushed back into the bladder, where it can be seized by the lithotrite.

In any of these exceptional cases in which litholapaxy can not be applied we have to make our choice between a perineal and a suprapubic incision. The danger attaching to the *perineal* incision is, according to present indications, decidedly less than that after the high operation, so long as it is applied to small or medium-sized stones; but when large stones are dealt with the facts are reversed, and the perineal operation becomes the more dangerous of the two. Under ordinary circumstances, as has been said, litholapaxy disposes of stones of a size suited for perineal removal, and these operations through the perinæum have therefore fallen largely into disuse in adult cases. They find occasional application in case of stones of moderate size, where false passages, anchylosis of the hip, or the presence of a foreign body, make litholapaxy impossible. A stone impacted in the neck of the bladder, if it can not be dislodged, may be properly removed through the perinæum.

*Suprapubic lithotomy* is to be employed in cases where the stone is too hard and large to be crushed, or where an impervious urethra makes the introduction of a lithotrite or staff impossible. In cases of encysted stone also the high operation is the best, as the thorough inspection of the bladder which it makes possible enables us to treat the conditions intelligently.

In old age the same indications are to be followed as in the adult, except that it is to be remembered that perineal incisions are especially dangerous for old men, and are not to be undertaken for the removal of a stone without urgent reasons. The suprapubic operation will therefore be called upon to deal with most of the stones that are unsuitable for litholapaxy. In cases of enlarged prostate, when it is desired to combine prostatotomy or prostatectomy with the removal of the stone, the high operation affords ample room for thorough inspection of the condition and the correction of it. It is in old men that the crushing operation has its most signal advantages; for, while the mortality of the cutting operations is very great, the ample size and the tolerance of the urethra and bladder make litholapaxy easy and comparatively safe.

## COMPLICATIONS WHICH MAY MODIFY OUR CHOICE OF OPERATION.

In what has been said, we have examined the general considerations which must influence our selection of an operative procedure. It remains to consider certain complications which sometimes exist in these cases, and which may modify our choice.

Occasionally the existence of some general disease not connected with the stone may so add to the danger of the operation as to make it wiser to palliate. Thus, affections of the heart and lungs may add great risk of death from anæsthesia. In these cases careful preliminary treatment may considerably modify the danger. Certain other general diseases make the system intolerant of cutting operations. Diabetes mellitus, Bright's disease, alcoholism, anæmia, and gout are prominent instances of general disease which interfere with the healthy healing of wounds, and in the presence of which one would give an added preference to litholapaxy.

In those cases of interstitial nephritis in which large quantities of urine of low specific gravity are excreted, the crushing operation is well borne; and I have known three litholapaxies to be done at intervals on such a patient, who died uræmic two or three years after the last one. To cutting operations, on the other hand, these patients frequently succumb. When to this interstitial nephritis is allied a chronic pyelitis, with dilated pelves and ureters, we have a far more grave condition. Unfortunately, this state of the urinary organs is not infrequent, brought about by those obstructive diseases of the prostate and urethra which also give rise to stone. Even under these unfavorable conditions, with careful preparation, an operation may be undertaken, and litholapaxy is much safer than any form of lithotomy. In fact, the increased relative safety of litholapaxy late in life is probably due to the renal complications so common in these old patients, which makes them very intolerant of cutting operations, while they bear lithotrity at one sitting remarkably well.

As has been said, a stricture in the urethra may be corrected as one step in the removal of a stone without seriously complicating the performance of a litholapaxy. In case of a serious stricture, however, which can not be properly treated by rapid dilatation or divulsion, and which therefore requires an incision for its correction, it may be wise at the same time to cut for the stone.

With an incision through a stricture in the perinæum, the posterior urethra may be dilated sufficiently to allow of the removal of a small stone with the forceps. If the calculus is too large for this, crushing instruments may be introduced through the perineal incision after the manner to be described later under Perineal Lithotrity. If the stricture is very close, so that the operation upon it would be difficult, and would add considerably to the shock of the lithotomy, it may be wise to remove the stone at once by suprapubic lithotomy, and, after the patient's condition has been improved by relief from the pain of the stone and by drainage of the bladder, to then undertake the correction of the stricture.

The enlargement of the prostate usually offers but slight obstruction to the introduction of instruments. It does, however, in some cases, considerably interfere with their use after they are in, and the changes in the shape of the bladder that it brings about may somewhat hamper the lithotritist. The way in which these difficulties are to be met will be considered in the description of that operation.

In the very rare cases in which the obstacles to lithotrity from this cause are too great to be overcome, a lithotomy must be done, and as a large, hard prostate greatly complicates and lengthens the route into the bladder, it will usually be found best to use the suprapubic incision for these cases.

In connection with a stone, conditions may exist in the bladder which themselves require operative treatment, and the proper operation being chosen for their correction, the removal of the stone is merely a secondary matter. Tumors of the bladder and tumors or outgrowths of the prostate may be mentioned here, and, as their treatment is fully considered elsewhere, I will not go into that question, but will only remind the reader that the symptoms of an enlarged prostate are greatly aggravated by the presence of a stone in the bladder, and that their discomforts often wholly subside upon the removal of the source of irritation. It is well, therefore, always to consider this, and in cases of doubt to do the comparatively safe litholapaxy first. By this course the patient will often be saved from the added danger of a suprapubic incision.

Severe chronic cystitis is also mentioned as a reason for opening the bladder. Keyes says: "Cystotomy, under such circumstances, deals with two maladies at once; and the greater risk of lithotomy is more than compensated for by the prospect of curing the cystitis; while the danger of acutely aggravating the chronic cystitis by the necessarily harsh manœuvres of litholapaxy makes the latter operation a second choice." I quote this statement at length, because, coming from so high an authority, it carries great weight; and it seems to me that such a rule, applied by men of less sound judgment than Prof. Keyes, might often lead to the choice of severer measures than the case demanded. In most of these cases the stone is the cause of the cystitis, and usually the removal of this cause allows the rapid subsidence of the bladder inflammation. It has not been my experience that the manœuvres of litholapaxy greatly aggravate even severe chronic cystitis; and it is well to remember that in old men, in whom these cases of cystitis usually occur, lateral lithotomy is about three times as dangerous as litholapaxy. A better way of meeting the indication for drainage of the bladder, when that is evidently important, is, I think, to remove the stone by litholapaxy, and then to introduce drainage through an opening in the membranous urethra (boutonnière), which operation leaves a much less extensive wound than a lateral lithotomy.

## PREPARATION FOR OPERATION.

An operation having been decided upon, it is important to put the patient and his urinary organs in the best possible condition before subjecting him to instrumentation. If the patient is strong, and the bladder reasonably healthy, but little preparation is required. When, however, the patient is old and broken in health, with urinary organs more or less disabled, a wise preliminary course of treatment will often considerably increase his chances of recovery.

First, the general health should be looked to. It is often possible sensibly to add to the strength of a feeble patient by putting him in bed and supplying the fullest quantity of very digestible food that the stomach can properly dispose of. Extra meals, the moderate exhibition of stimulants, with a liberal supply of milk, will accomplish much in this effort to artificially manufacture strength. In old men with diseased kidneys, the action of the heart is often seriously enfeebled, and cardiac stimulants are then of prime importance. Aside from this, the ordinary tonic treatment suitable for each case is to be applied, and the regular action of the bowels is to be provided for.

It is next important to investigate the action of the kidneys and the condition of the bladder. The daily amount of urine, taken together with the specific gravity, or a quantitative test of the urea, enable one to determine whether the kidneys are accomplishing a sufficient amount of work. If the urine is small in quantity, and of high specific gravity, or if it is about normal in amount (between forty and fifty ounces), but of low specific gravity, an effort should be made to increase the amount by the free administration of water and milk. Digitalis may act as an efficient diuretic, if the heart's action is feeble.

Next, an examination of the urine should be made, and if evidence of serious disease of the kidneys exists, or if sugar is present in any considerable amount, the proper treatment should be instituted to correct these conditions as far as may be done. If the urine is ammoniacal or putrid in odor, efforts should be made to stop the fermentation and to restore its normal acidity. This is as important a compliance with the rules of antiseptic surgery as the effort to clear any field of operation of infective germs. The measures to be adopted to this end are both general and local. The general measures consist in the administration of large quantities of water to flush the urinary passages, with the addition of certain drugs which are excreted through the kidneys and have some effect in supplying an antiseptic quality to the urine. The benzoates, salicylates, boracic acid, eucalyptol, and sandal-wood oil, may be mentioned as the more efficient of this class of remedies.

The local treatment of these conditions is even more important than the general, and consists in the systematic removal of the residual urine with a catheter and irrigation of the bladder. The advantages of irrigation are largely due to the mechanical effect of removing the last remains of the urine and mucus. Certain drugs, however, in the irrigating fluid may, by being mildly antiseptic or astringent, add to the efficacy of these injections. The more useful irrigating fluids are borax, or boracic acid, one drachm to the pint of water, permanganate of potash, or carbolic acid in very dilute solution, and acetate or sulphate of zinc well diluted. Oftentimes very weak solutions of nitrate of silver, one-half grain to one grain in an ounce of water, exercise a very beneficial effect in these cases. This is better used as an occasional wash, some milder solution being employed in the intervals. When the urine is strongly ammoniacal and loaded with triple phosphates, dilute solutions of nitric acid will often be of great service.

These injections must be properly managed with care and judgment, in order that they may not be a source of irritation rather than of soothing to the bladder. If there is a strong tendency to spasm, and the bladder shuts down painfully on to the stone at each emptying, the use of irrigation is of doubtful advantage. In such a case the quantity injected each time should be small, so that it may not distend the bladder and put it in a condition of spasm. When such a patient can not bear the injections, the correction of the urine may be accomplished, although more slowly, by putting him in bed with the hips raised, so as to roll the stone away from the sensitive neck of the bladder, and then instituting the general treatment outlined above, with the addition of opium or belladonna to keep the bladder at rest.

If these measures fail of success, and it is evident that the irritation of the stone is more powerful to keep up the inflammation of the bladder than any measures at our command are to diminish it, the operation must be proceeded with at once, and the stone, the exciting cause of the cystitis, must be removed, even under these unfavorable conditions

Some operators prepare the urethra before lithotrity by the passage of large sounds, and by the operative treatment of stricture, if such exists. The previous use of sounds to prepare the urethra for instrumentation seems to me unnecessary, and the operation upon any existing stricture can be readily and properly combined with the operation for the removal of the stone. A sufficient preliminary examination of the urethra to ascertain the character of any such complications is wise, as a knowledge of them may modify the plan of operation.

As a precaution against the occurrence of chill after the operation, the previous administration of quinine and morphine has been recommended. Keyes prefers a combination of pilocarpine and morphine. I have for a long time operated without any such preparation, and have no reason to regret the omission. On the morning of the operation the stomach should be kept empty, but a little spirit may be administered, if the patient is feeble.

We have shown the crushing of the stone to be the operation of choice whenever it is possible, and we will consequently consider this method first, even though it is the most modern.

## 1. Lithotrity.

**History and Development.**—The idea of mechanically pulverizing a stone by instruments introduced through the urethra is by no means modern. In early Arab writings the suggestion is made of wearing down the calculus by attrition with a diamond fixed on a wire and thus introduced into the bladder. Mention of these procedures is made in the works of Albucasis in the twelfth century. In 1580 Sanctorius suggests the possibility of extracting little calculi with three-branched forceps. According to Haller, Sanctorius even proposed perforating them with a stylet, when they were too large to be removed whole. The imperfection of methods, however, in those early days prevented the operation from obtaining a foothold among the accepted procedures of surgery, and practical lithotrity, therefore, waited to be an invention of the nineteenth century.

In 1813 Gruithuisen demonstrated the possibility of catheterization with a straight instrument, and showed that the urethra was much more dilatable than had been previously supposed. He introduced straight sounds over three and a half lines in diameter, and proposed to operate on stones by snaring them with a wire projected through the end of a straight tube and then perforating them with a drill. He never carried this plan into practice.

A few years later Civiale began to interest himself in this operation, and after several attempts produced an instrument in which a three-branched forceps held the stone, while a drill perforated it. As has been said, Sanctorius proposed such a plan centuries before, but to Civiale is due the credit of applying it practically and making it succeed. Leroy was working on parallel lines with Civiale, and produced at about the same time a forceps with three branches which held the stone, while it

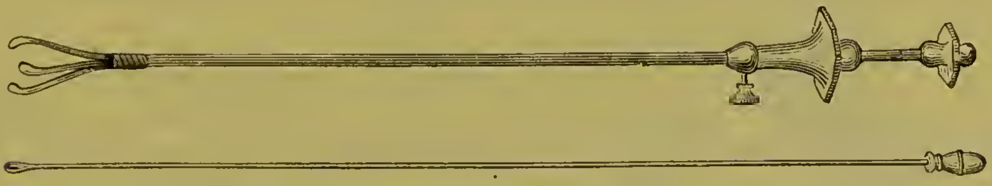

Fig. 14.—Civiale's trilabe or litholabe.

was operated upon with a saw. It fell to Civiale, however, to be the first to put his instrument to practical use, and in 1824, before the Academy of Medicine in Paris, he operated upon two patients successfully. These fortunate results of Civiale aroused the mechanical ingenuity of other surgeons, and at once the greatest activity was shown in devising improvements in the form of crushing instruments.

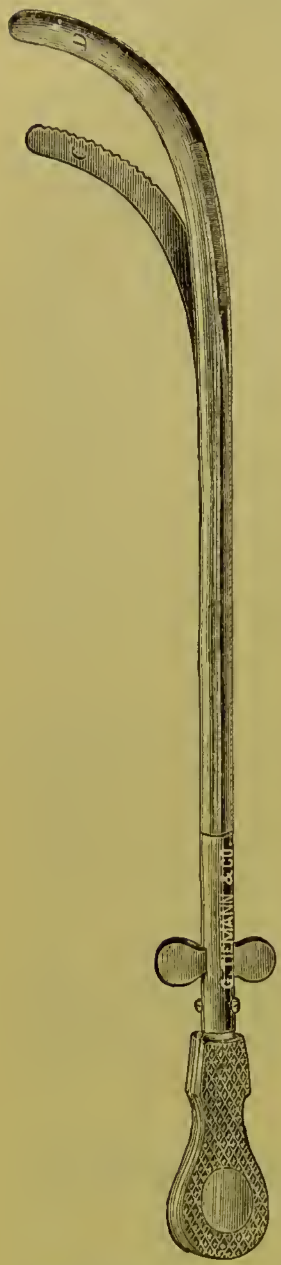
Fig. 15.—Weiss's first lithotrite.

While Civiale and Leroy were interesting themselves in perfecting instruments which had for their object the perforation and gradual wearing away of the stone, other inventors were addressing themselves to the discovery of means for the direct crushing of stones, either by percussion or pressure. In 1822 Amussat had brought out his "brise-pierre," which was a straight tube through which a two-branched forceps was worked, the branches being separately movable. This instrument was designed to catch the stone and then rub it down between its jaws. The brise-coque of Heurteloup was a somewhat nicer adaptation of the same principle. But neither of them worked in practice.

The difficulty of introducing a straight instrument led to many efforts to adapt a curved lithotrite to the requirements of the crushing operation. In 1824 Weiss constructed such an instrument, with two blades, with shafts working parallel, and with blades which were in principle the same as those of the present instruments. The force in this instrument was applied by a screw. Retoré and Haygarth devised similar instruments in 1825. In all these early lithotrites, however, the shafts were insecurely fastened together, and force which could be safely applied was not sufficient for the purpose of breaking the stone.

In 1830, Jacobson, of Copenhagen, introduced a lithotrite which had one solid blade and one blade articulated like a chain-saw. The stone was to be caught in the loop made between these two, and crushed by screw force drawing the articulated blade down on to the solid one. This instrument, while useful for small stones, proved insufficient for large ones, and with it it was difficult to find and seize fragments after the first crushing.

In 1832 Heurteloup brought out his lithotrite, called a *percuteur*, in which the force was applied by the blows of a hammer. The blades in this instrument were practically like those of Weiss's and Retoré's lithotrites, but the shaft was somewhat differently arranged for the purpose of giving more strength. The shaft was made of three pieces, the outer ones of which were attached to the female blade, and the middle one, which slipped to and fro between them, carried the male blade. The two outside pieces of the shaft were joined in the lower part by a cross-rivet, and in the shaft of the male blade was a long slit through which this rivet passed, which was designed to prevent the riding up of the male blade when pressure was brought upon the stone between its jaws. In practice this arrangement was found not strong enough to deal with stones of any hardness, and in one disastrous case Sir Benjamin Brodie was obliged to do lithotomy to release the jaws of the instrument, which had sprung apart in this manner.

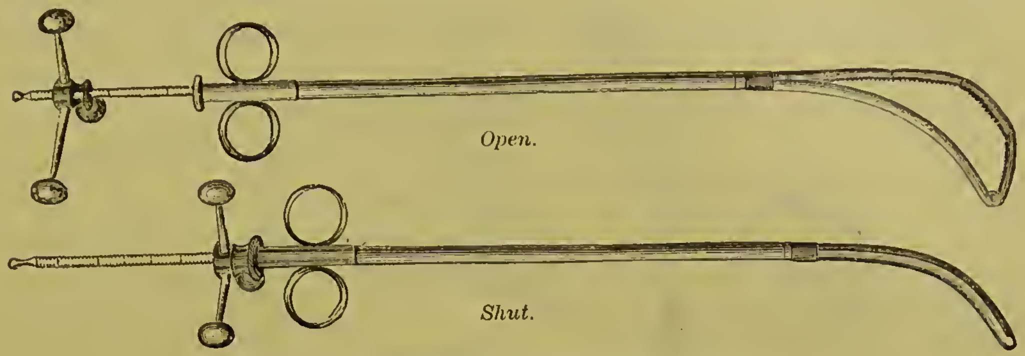

Fig. 16.—Jacobson's lithotrite, open and shut.

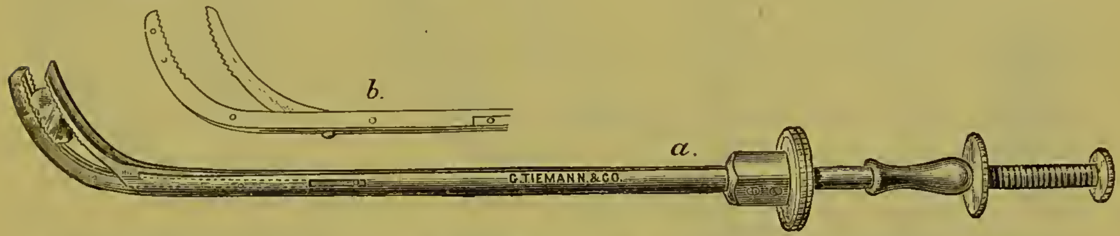

Fig. 17.—Heurteloup's percuteur. *a* shows the riding up of the male blade when pressure is applied; *b* shows check-button added by Costello.

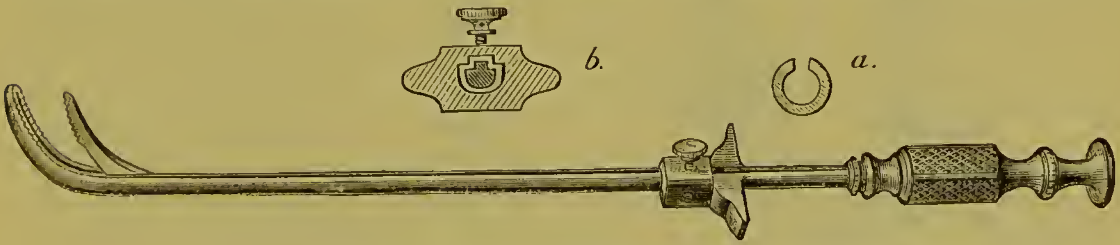

Fig. 18.—Costello's lithotrite. *a*, section of shaft of female blade.

To remedy this defect, Costello fastened a button on the lower side of the male blade, close down to the heel of the instrument, which, overlapping the lateral pieces of the female shaft, prevented this riding up to a considerable extent (Fig. 17, *b*). A little later (1832), Costello, finding that even with this modification the instrument did not work satisfactorily, devised, and himself made, an instrument in which the shaft of the male blade ran within a corresponding groove in the female blade, the shoulders of which groove held it down (Fig. 18), and thus entirely prevented the riding up which had been so troublesome in Heurteloup's percuteur. This final modification has been retained up to the present day, and no essential change has been made in the shaft of the instrument since that time. This lithotrite of Costello's was operated by percussion.

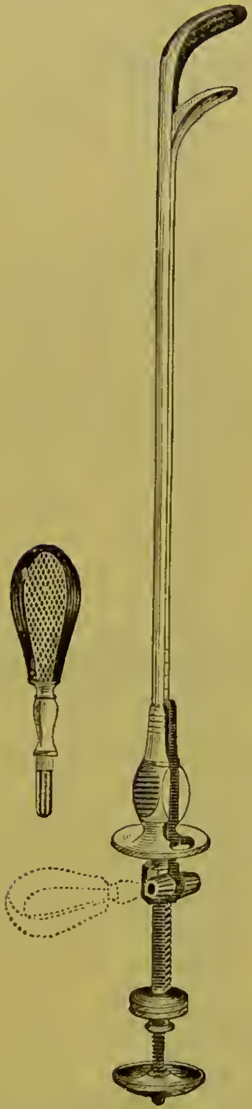

Fig. 19.—Ferguson's lithotrite.

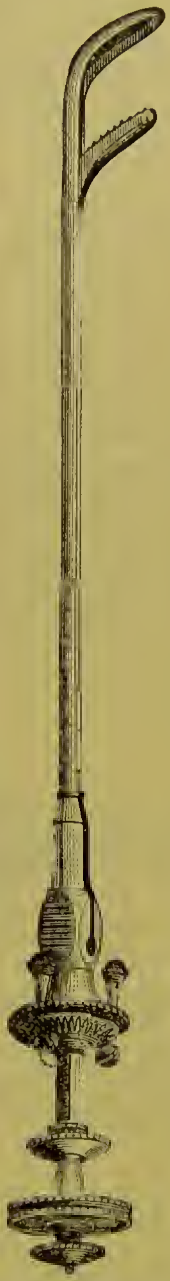

Fig. 20.—Civiale's lithotriptor.

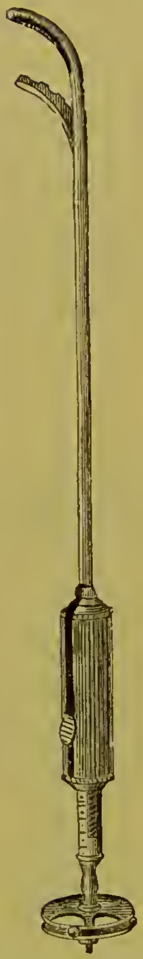

Fig. 21.—Thompson's lithotrite.

The instrument now possessing blades suitable for catching the stone, and a shaft strong enough to exert crushing power safely, the attention of inventors was turned to the management of the force, and screw power came very quickly into general use. At first fear was felt that the bladder would be injured by fragments flying off, but this was found, in a bladder filled with water, not to be the case. It was evidently important that the blades should slide easily upon each other while searching for and seizing the stone, and that then the force should be in some way applied to them. Ferguson accomplished this by a rack and pinion upon the handle of the instrument (Fig. 19), but very soon Charrière devised an arrangement in which a twist given to the lock threw the screw in or out of action (Fig. 20). Later, Thompson added a cylindrical handle, which surrounded the screw and gave a firm grasp to the left hand. Weiss added to this the contrivance by which the screw was thrown in and out of action by sliding a button, and this arrangement is still preserved in Thompson's lithotrite (Fig. 21).

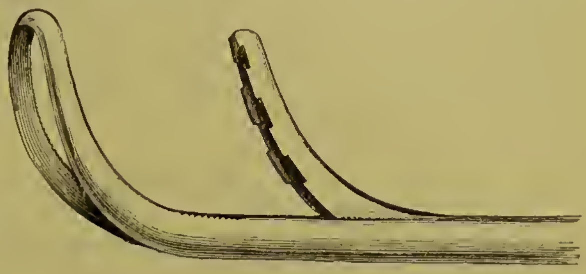

Fig. 22.—Fenestrated blade.

Now attention was again turned to the blades of the instrument, which were made stronger; and, with the object of preventing clogging by *débris*, the fenestrated female blade was devised, the male blade being roughened in various ways to enable it to hold fragments from slipping during the crushing. The accompanying cuts present most of the important modifications which had appeared up to the year 1878, when the introduction of litholapaxy increased the need of powerful, rapidly working and non-clogging instruments, and these will be considered when describing the operation.

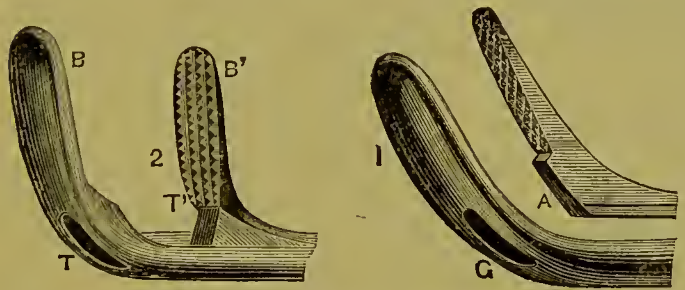

Fig. 23.—Solid blades of lithotrite.

From the time of the introduction of lithotrity, the practice was to crush the stone by numerous short sittings, and the natural expulsive power of the bladder was relied upon to throw out the *débris* thus produced. The operator usually contented himself with seizing the stone but two or three times in one sitting. After one of these crushings it was the practice to have the patient remain in bed on his back for a few days, in order to let the sharp edges of the fragments become rounded off before they were expelled through the urethra.

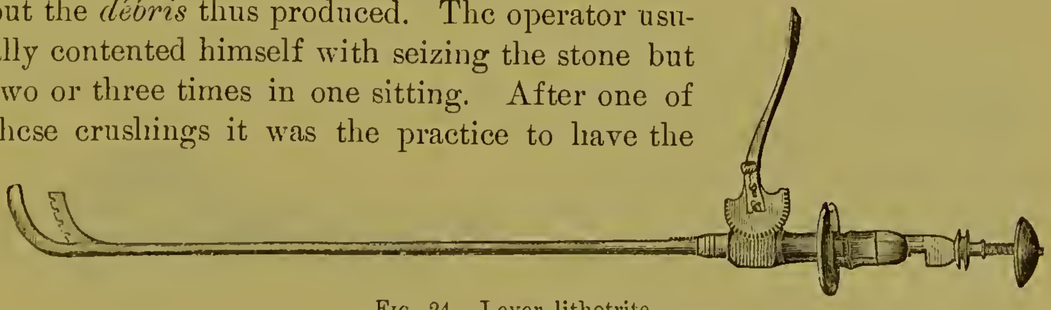

Fig. 24.—Lever lithotrite.

The frequency with which stone is complicated by an obstruction to urination soon set the early lithotritists to devising means for the removal of crushed fragments by means of scoops and by the use of large catheters; and presently by the adaptation of suction to the catheters. Figs. 25, 26, 27, 28, and 29 give the more important of these early aspirating instruments; and, as will be seen, they owed their suction either to a piston (Cornay, Crampton, Nélaton), or to the expansion of a rubber bulb (Mercier, Clover, Van Buren); and these instruments were designed especially for those cases in which, either through atony or obstruction to the urethra, the bladder had lost the power of satisfactorily voiding its contents.

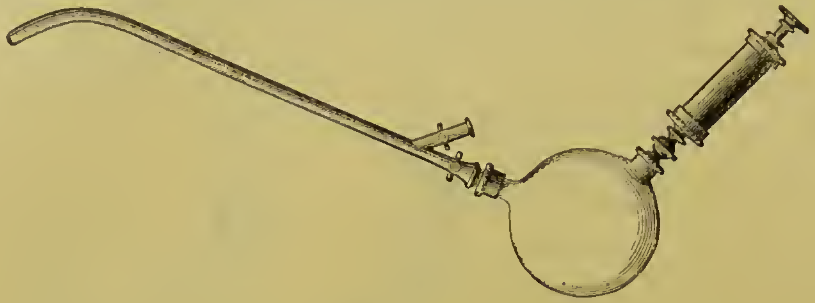

Fig. 25.—Cornay's washing-bottle.

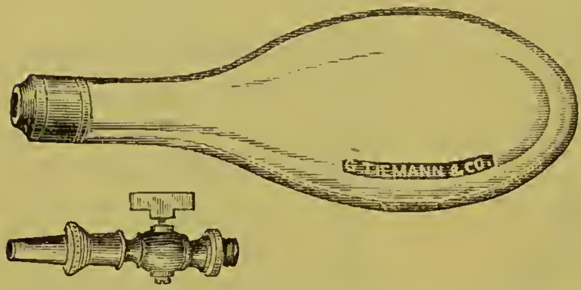

Fig. 26.—Crampton's bottle, used with an exhaust-pump.

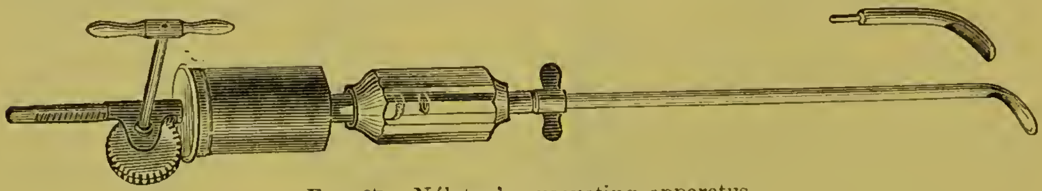

Fig. 27.—Nélaton's evacuating apparatus.

The employment of evacuating apparatus was, however, up to the year 1878 regarded as of doubtful advantage, or even detrimental. Gross, in 1876, says: "The practice of injecting the bladder to wash out the detritus is obsolete. . . . This apparatus of Mr. Clover should not be employed, if it is possible to dispense with it, as its use is quite as irritating as lithotrity itself."

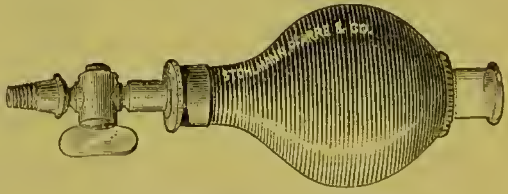

Fig. 28.—Mercier's washing-bottle.

Contemporaneous French writers are almost equally strong in condemning the practice; and Thompson, holding a somewhat more favorable opinion, said in 1871: "Having used it (Clover's bottle) very frequently, I would add that it is necessary to use all such apparatus with extreme gentleness; and I prefer to do without it, if possible."

These quotations reflect as well as may be the commonly received opinion at that time upon this procedure; and the caution with which surgeons then approached the bladder is further shown by the shortness of the sittings that were thought proper in lithotrity. Two to three, or at most five minutes, was the usually prescribed range of time. After the year 1871 it became more usual to employ an anæsthetic and to spend more time, and so do more crushing at one sitting; but even these sittings were comparatively short, usually not more than ten or fifteen minutes.

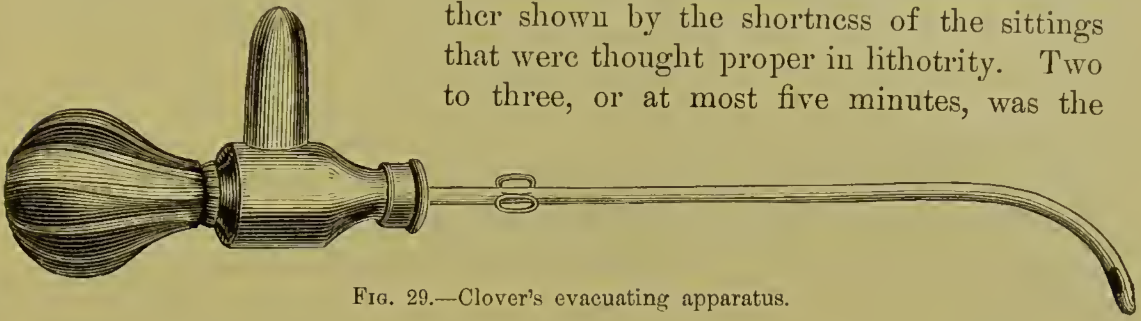

FIG. 29.—Clover's evacuating apparatus.

During this time, while lithotrity was slowly establishing itself as the proper operation for small and soft stones in comparatively healthy bladders, the operation of lithotomy was not standing still; for, although no new operative procedure was added to its technique, the introduction of antiseptic measures did so much to rob it of its dangers, that it began to be a not uncommonly expressed opinion that the cutting operation, which at once thoroughly removed the stone, was likely to displace the crushing operation, which was more tedious in its performance and less certain in its results.

Such was the position of things when, in 1878, Bigelow published his operation of litholapaxy, in which thorough crushing was combined with complete evacuation; and this method of stone removal has proved itself of such great practical value that cutting operations are now the exception, and not, as formerly, the rule.

Such is the brief *résumé* of the history of the crushing of stone in the bladder, and it offers as interesting a chapter of surgical evolution as can be found in any branch of our art. Even this short statement will give some idea of the amount of thought devoted to the technique of the operation, and of the mechanical skill and ingenuity expended in devising instruments for furthering the crushing of the stone and the removal of the fragments.

The modern operation of litholapaxy, or lithotrity in one sitting, has absorbed the older methods, and stands as the representative of them all. It is rare indeed now for a surgeon to plan the crushing of a stone, without including in his scheme of operation the immediate evacuation of the fragments.

The description of litholapaxy which follows is intended, therefore, to include what seems valuable of the experiences gathered in the field of lithotrity, together with all that has been added to it since the evacuator came to the assistance of the lithotrite.

## 2. Litholapaxy.

The name of this operation was derived by Bigelow from λίθος, *a stone*, and λάπαξις, *evacuation*. Thus it covers not only the operations in which a stone is crushed and pumped out, but also those not infrequent cases in which small stones are drawn out through the tube without crushing.

Bigelow, having convinced himself that the inflammations which followed crushing operations were due rather to the irritation of the fragments which were left than to the contact of the instruments, and believing that the bladder was much more tolerant of instrumentation than had been supposed, devoted his attention to the devising of more perfect apparatus for the evacuation of the fragments after crushing. His experiments showing him that the *débris* could be rapidly removed, provided that the crushing had been thorough, he then set about improving the lithotrites with the object of making them more efficient.

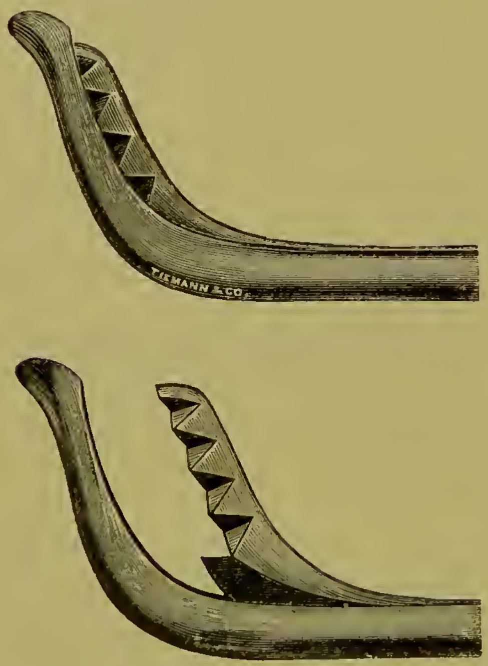

Fig. 30.—Blades of Bigelow's lithotrite, open and shut.

For convenience of arrangement we will describe first the alterations that he made in the lithotrite; we then will examine the mechanism of the evacuator; and, finally, will consider the methods of using these instruments in the operation.

**Lithotrite.** — The alterations in this instrument were, first, in the blades; and, second, in the lock and handle:

1. Prior to this time considerable difficulty was experienced from the impaction of the mortar-like stone between the blades or jaws. This, as has been said, was obviated by making the female blade fenestrated, so that the male blade pushed the *débris* directly through it. This worked well, so far as the crushing of

the stone went, but, for certain reasons which will be dwelt upon in the description of the operation, the fenestrated instrument required more care in its manipulation, and was more likely to damage the bladder walls than an instrument with a solid blade.

To provide, then, a solid-bladed lithotrite that should be self-clearing and could be used for an indefinite time without becoming clogged, Bigelow had the male blade made with a series of alternate, triangular notches, by whose inclined planes the detritus should escape laterally, after being crushed against the floor and rim of the shoe, or female blade.

The rim of the female blade he made low, so that this detritus should easily escape over it, and also that the fragments of stone should readily fall or slide upon it. At the heel of the shoe, where most of the stone is usually comminuted, and where the impact is therefore greatest, the floor was made high, so that it should more easily discharge itself laterally, while the customary slot (Fig. 31) was made to work effectively.

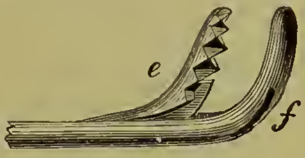

Fig. 31.—Heel of Bigelow's lithotrite, showing the slot for the escape of detritus.

To facilitate the introduction of this instrument, the point of the female blade was turned over and blunted. The advantage of this form in enabling the instrument to slip easily along the urethra is illustrated in Fig. 32.

Keyes objected to this form because, with the instrument reversed for the purpose of picking up fragments with the tip of the blades, the snout prevents the seizing part of the blade from coming down closely upon the bladder floor. This manœuvre, however, which is thus interfered with, is one of the most dangerous in the manipulation of the instrument, and, though proper in skillful hands, should not be used if it can be dispensed with.

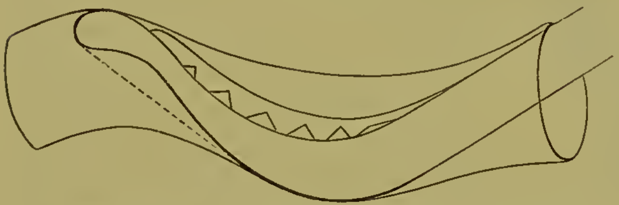

Fig. 32.—Diagram of urethra with blade of lithotrite within it.

2. The handle of the instrument was also modified in important particulars. In place of the wheel, Bigelow substituted an egg-shaped, fluted handle of hard rubber that comfortably fits the palm of the hand. Immediately below this handle he placed a revolving cylinder cap which is attached to the screw-guard, and which, being held between the forefinger and thumb of the right hand, enables the operator to turn the lock by a half-turn of the wrist without changing his hold on the handle. This arrangement gives the surgeon the great advantage of being able to lock and unlock the instrument at will, and even to complete a protracted crushing without disengaging the hold of either hand. It thus saves time and lends accuracy to the manipulations.

In selecting the proper lithotrite for a given case, the size of the urethra should be taken into account, and the largest instrument that will pass without undue stretching of the canal should be used. A powerful lithotrite works more rapidly and easily than a weaker one, and there is less danger of its breaking. On the other hand, it should not fit the urethra so tightly as to interfere with its free manipulation.

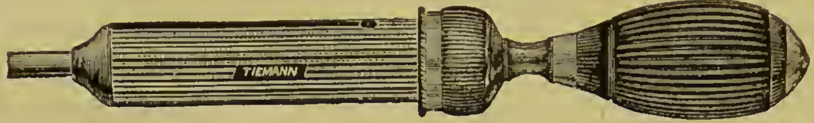

FIG. 33.—Handle of Bigelow's lithotrite, closed.

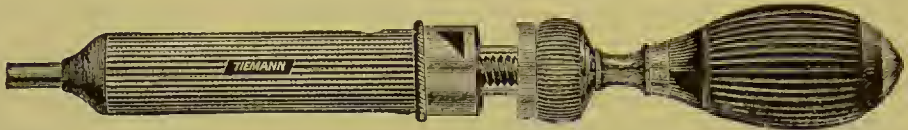

FIG. 34.—Handle of Bigelow's lithotrite, open, showing the cylinder-cap and the bars connecting it with the screw-guard.

Bigelow's lithotrites for the adult are made in three sizes, namely, Nos. 25, 27, and 31 of the French catheter scale. This measurement is taken round the heel of the blades, which is the largest part; the shaft is several sizes smaller. With well-made instruments of these sizes moderate stones of any degree of hardness may be disposed of. For a large and hard stone that offers more than usual resistance a fenestrated instrument may be employed for the first crushing, as it cuts through the stone more readily. After the calculus is divided into fragments the instrument with the closed female blade may be taken for the further comminution of them, as it can be operated with more freedom and speed.

In operating upon children, instruments much smaller than these (Nos. 16 and 20 French) are employed. Here, except with very small stones, a fenestrated lithotrite is an advantage, often a necessity, as it cuts the stone more easily and is therefore less likely to break. To finally reduce the fragments to a size that will pass the small evacuating tubes, however, an instrument with a solid blade is a great convenience.

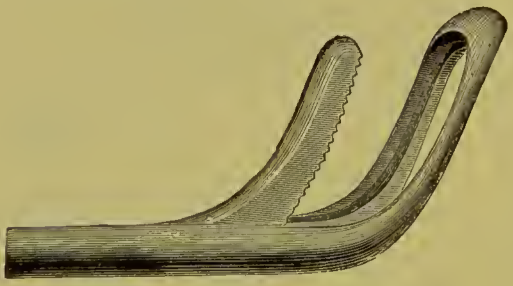

FIG. 35.—Bigelow's fenestrated blades.

**The Evacuator.**—Much ingenuity has been expended in devising modifications of the evacuating apparatus. The essential points of this are a tube, or catheter, an elastic ball, and a receptacle for fragments. This last part may even be omitted, the fragments collecting in the lower part of the bulb. For convenience, however, to enable the operator to see what he is accomplishing and to guide his manipulations accordingly, a transparent receiver is an important part of the apparatus.

In an early article Bigelow published a series of figures showing the important combinations which could be made of these three parts; and, after trying several arrangements, he decided upon one which will be described later. Some operators have preferred other solutions of this problem, and have changed the form of evacuator to suit their individual tastes. The accompanying figures present the more important of these alterations of form, in all of which the essential principles remain the same.

For the sake of brevity we will first give a description of Bigelow's "simplified evacuator," and will then consider those changes of form which have attained any degree of prominence.

The evacuator consists, as has been said, of a tube, an elastic bulb, and a receptacle for fragments. For convenience of description the tube may be described as consisting of two parts: the movable part, or catheter, and the fixed part, which enters the bulb and is attached to it by a bayonet-joint.

The catheter may be either curved or straight. A straight tube offers less resistance to the passage of fragments, and is therefore better for the evacuation of them. The curved tube, however, is much easier of introduction in difficult cases. At the upper end of the catheter tube is a projecting wing, which facilitates the handling of the instrument, and at the same time serves as a guide to the position of the mouth of the tube.

The fixed portion of the tube, connecting the catheter with the pump, extends obliquely upward to the center of the bulb. This tube is, for convenience, provided with a stop-cock just outside of the bulb, and, if a second stop-cock is attached to the upper end of the catheter, the patient and bedding can be kept dry when coupling and uncoupling these tubes.

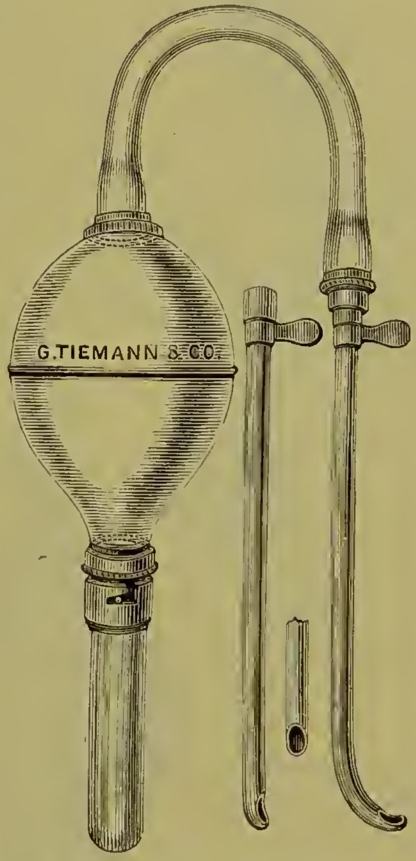

FIG. 36.—Bigelow's evacuator, first form.

The portion of the tube which extends into the bulb is perforated all around with small holes, the aggregate area of which is larger than that of the opening at the end of the tube. The fragments enter the bulb easily through this tube, while, as the water is forced back into the bladder, it naturally seeks the shortest road and freest outlet through the perforations in the sides of the tube, which do not admit of the return of the fragments. The solid particles which are thus caught and retained in the bulb naturally gravitate to the bottom of it, where they are received in the glass ball or receiver, which can be readily removed and emptied. At the top of the bulb is an opening with a stop-

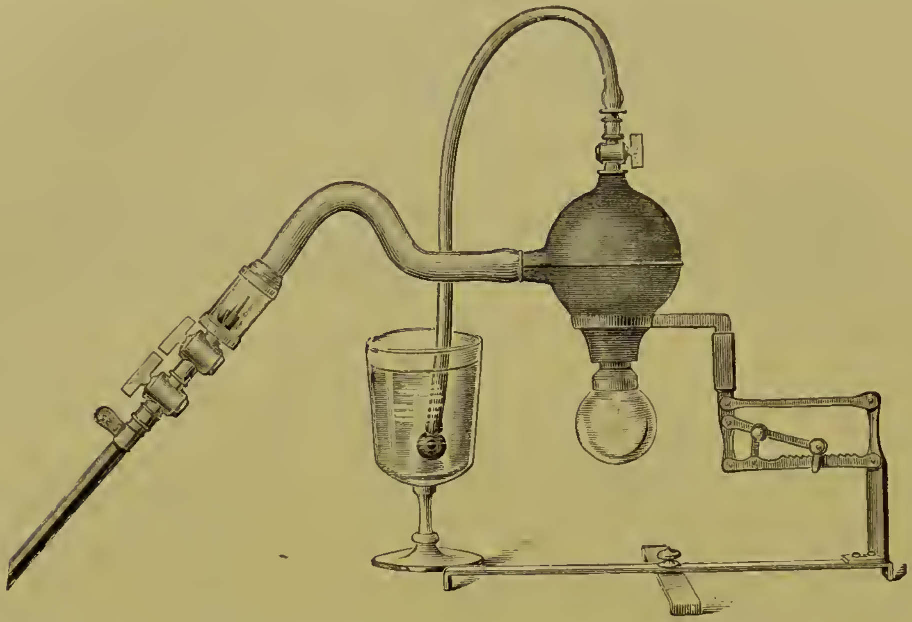

Fig. 37.—Bigelow's evacuator, second form. This form was used but for a short time, as the simplified evacuator followed closely after it.

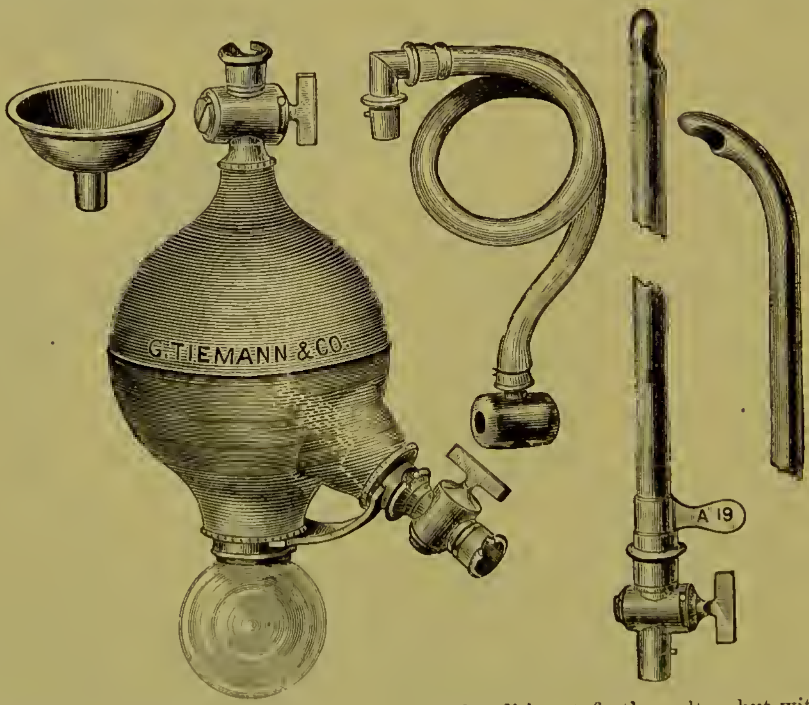

Fig. 38.—Bigelow's simplified evacuator. This form he did not further alter, but with it all his later cases were operated.

cock to which a hose can be attached. This provides for the expulsion of air from the apparatus, and also for the easy regulation of the amount of water in the bulb and bladder during evacuation—a matter of great importance, as an over-tense bladder is a source of danger and must be at once relieved; while a too empty bladder interferes greatly with the operation, as the lax walls are drawn into and obstruct the mouth of the tube.

In Bigelow's evacuator, as will be seen, the receiver in which the fragments are caught is at the extreme farthermost point of the apparatus from the bladder, and fragments once received in it can not be again put in circulation and returned to the bladder.

In Thompson's, Guyon's, and Otis's instruments, on the other hand, the trap or receiver is between the bulb, or pump, and the bladder. The return of the fragments is guarded against in Thompson's instrument (Fig. 42) by a perforated valve at the end of the tube. The presence of much mucus in the bladder interferes somewhat with the efficiency of this arrangement. In both Guyon's and Otis's instruments there are no valves, the force of gravity being relied upon to separate the fragments and sand from the water; and to assist this, the direction of the current is so arranged as to guide the fragments toward the receptacle provided for them. Walker's and Chismore's evacuators are modifications of Otis's; at least they follow it in principle. The Otis evacuator serves well for the

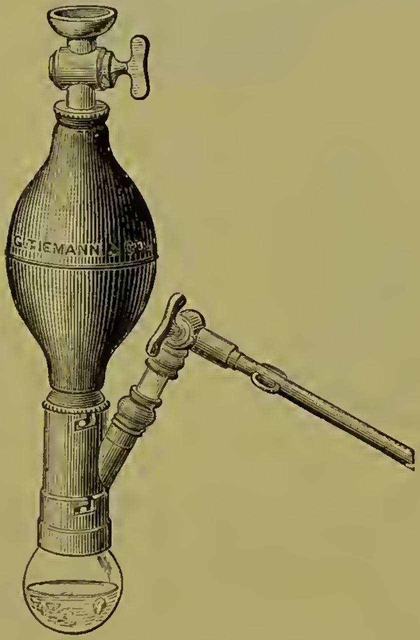

FIG. 39.—Guyon's evacuator.

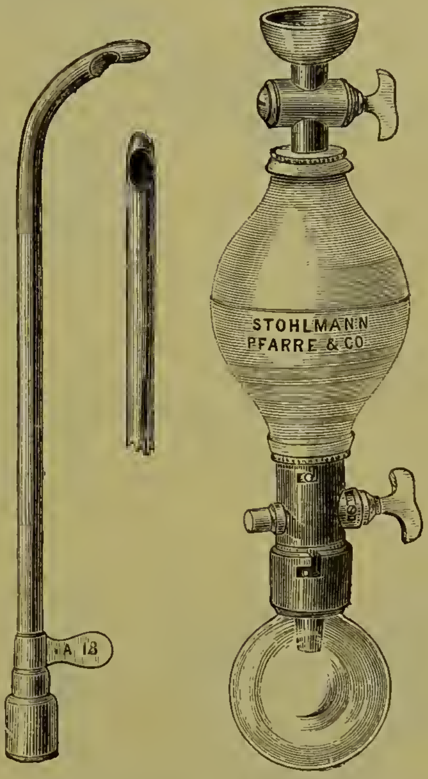

FIG. 40.—Thompson's evacuator, early form.

pumping out of fragments, but, as it can not be wholly freed from air, it makes so much bubbling and noise that it prevents the ear from accurately distinguishing the sound of fragments against the tube. This is a considerable disadvantage, for by the ear much may be learned as to the

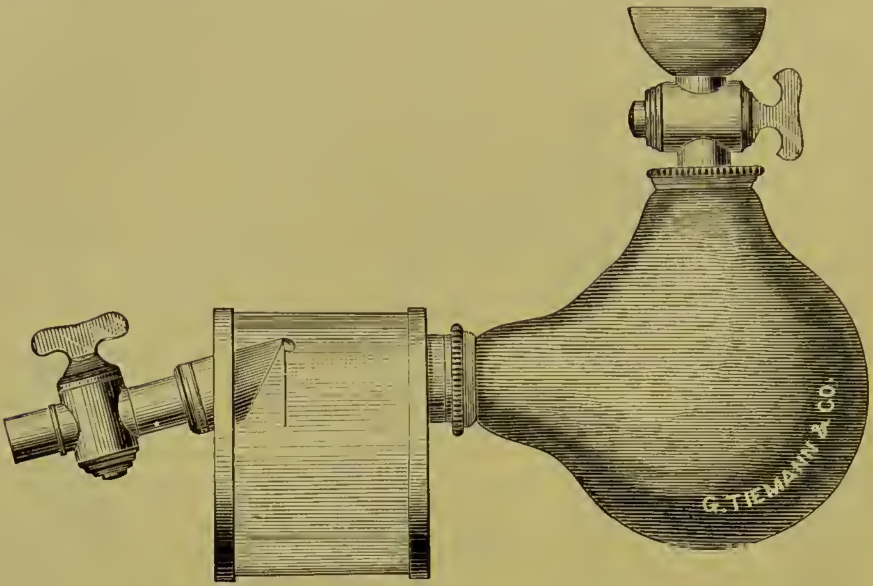

FIG. 41.—Thompson's evacuator, latest form.

working of the instrument and the size and abundance of the fragments. In the search for the last fragment or for a small stone the ready perception of a click is of the greatest importance.

The opening of the tube was a subject of much thought and experiment, and Bigelow endeavored to place it as close as possible to the extremity, so that it could be carried down to the floor of the bladder to collect the last fragments. At the same time he shaped the end so that the mucous membrane should be held away from the opening, and not be sucked into it. He made the opening slightly smaller than the caliber of the tube, so that a fragment which has once passed it shall not be arrested in the tube higher up. This arrangement prevents the stoppage of the tube higher up by a fragment, but it does not prevent bits of stone from lodging in the eye and obstructing it. The projecting lip below the opening will sometimes hold a fragment quite firmly when it is impacted in the eye, so that the force of the current can not throw it out, and a stylet is required for its dislodgment.

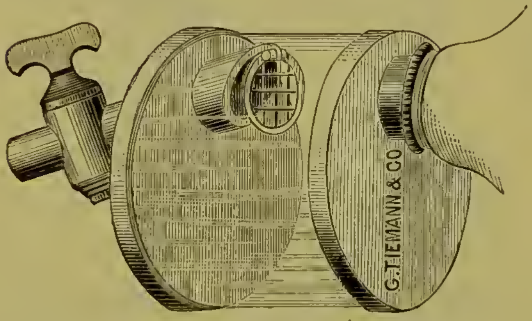

FIG. 42.—Thompson's evacuator, detail of receiver.

Keyes, endeavoring to avoid this impaction, has made an evacuating tube entirely open at the end. It requires an obturator for its introduction, and special skill in its management. The working of these tubes will be considered in the description of the operation.

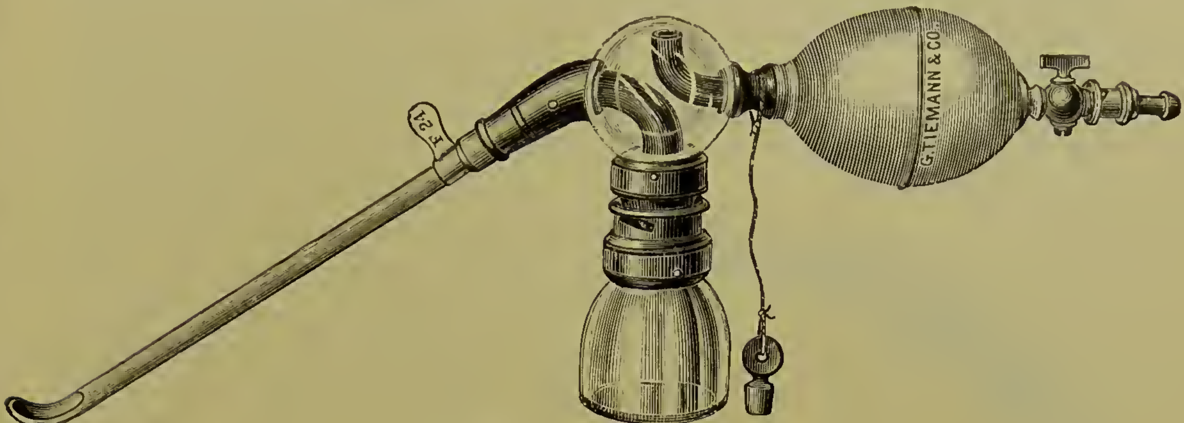

Fig. 43.—Otis's evacuator.

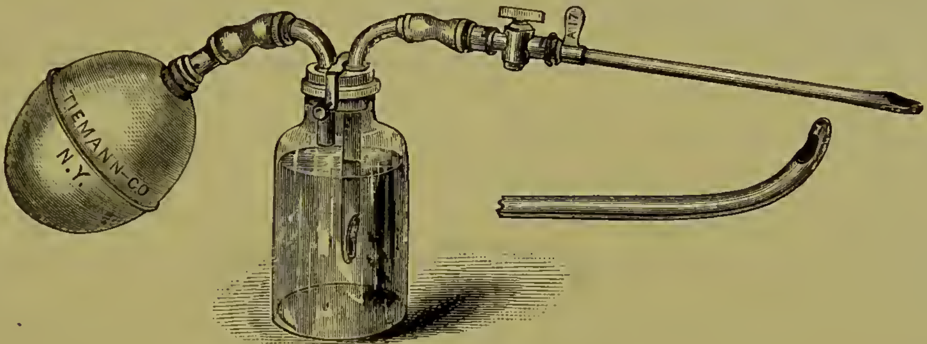

Fig. 44.—Walker's evacuator.

In regard to the size of the tubes, obviously the larger tubes will work more rapidly, and therefore should be used when the urethra will readily admit them.

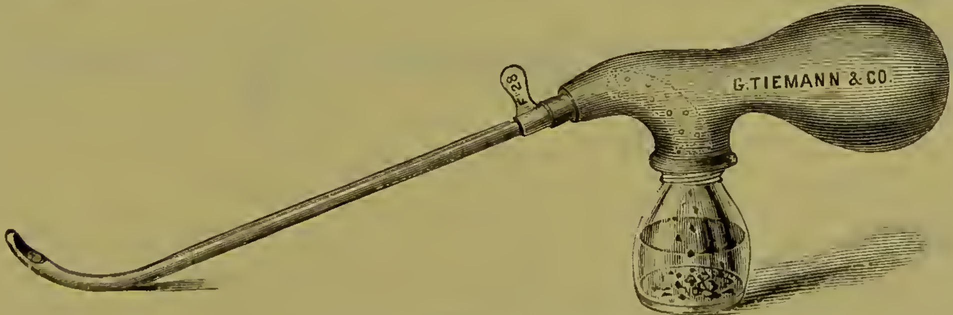

Fig. 45.—Chismore's evacuator.

There has been a mistaken idea that Bigelow advocated the use of very large tubes and lithotrites. He belonged to the older school of surgeons, who had been in the habit of using much smaller instruments than those now employed, and when he urged the use of large instruments, he did not propose to go into the largest sizes which Otis has shown that many urethræ will carry. To him, accustomed to look upon No. 21 French as a large sound, the numbers above 25 French seemed very large, and he so spoke of them. As a matter of fact, the largest instrument ever used by him in the operation of litholapaxy was a No. 31 French, and this he only employed on rare occasions, operating usually with instruments between 25 and 29, French scale.

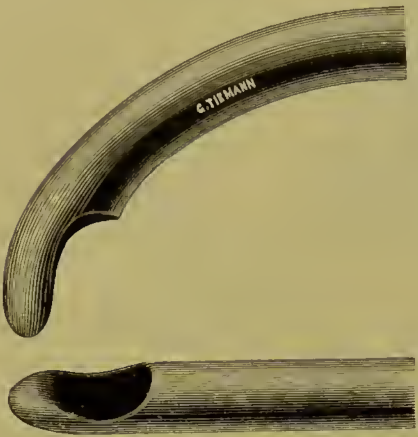

Fig. 46.—Ends of evacuating tubes.

The proper length of tube is another point which has been somewhat discussed. It is obvious that a short tube will work somewhat more rapidly than a longer one. This is not so important as it might at first appear, as the difference between the amount of fluid drawn in through a long and a short tube, at a given expansion of the bulb, is only a matter of one to one and a half drachm, and a slightly deeper compression of the bulb each time will make up this difference. In a fat patient with a long prostate, the tube as designed by Bigelow, measuring nine inches from the wing to the eye, is almost completely buried in the urethra; and it is obviously an advantage to have the receiver sufficiently above the patient to be easily visible, and not to have it buried between the thighs, as it would often be if a short tube were employed. If a surgeon has a large number of tubes, it is well to have them of various lengths.

The second stop-cock on the end of the catheter adds to the length of the evacuating tube. This slight disadvantage is, however, more than compensated for by the added comfort and convenience which it gives. It saves the patient and his bedding from a wetting, and prevents the loss of unmeasured quantities of fluid from the bladder. This last is sometimes of great importance, for in a small, contracted bladder it is necessary to be always cognizant of the amount of distention.

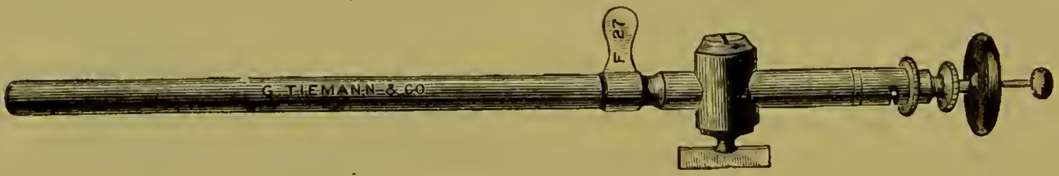

Fig. 47.—Keyes's evacuating tube.

## THE OPERATION.

Small stones can ordinarily be crushed and pumped out without causing much pain; so that, in a patient who is not especially sensitive, or whose urethra is accustomed to the passage of instruments, no anæsthetic may be required. The pain of the operation may be decidedly diminished by the application of cocaine to the bladder and urethra, and in this way many stones have been crushed without resorting to general anæsthesia. If cocaine is employed, it should be thoroughly applied in a two to four per cent solution, the bladder having been previously emptied and washed out. In order to reach all parts of the vesical cavity, it must be injected in considerable quantity, and there is therefore some danger of toxic effect, especially if the bladder is ulcerated and presents an absorbing surface.

Usually, except in the most trivial cases, it is best to do the operation under general anæsthesia; for the relaxation of complete insensibility makes the manipulations much easier, and adds greatly to the quickness and thoroughness of the operation. Especially is it important to allay the tendency of the bladder to spasmodic contractions, for not only does this force the water out alongside of the instruments, and so reduce the size of the cavity when room within it is necessary, but it subjects the bladder walls to a dangerous strain, which, if the urethra is blocked, may lead to their rupture.

The patient, then, being thoroughly anæsthetized, and the presence of a stone having been established, a large sound may be passed, to make sure that there is no stricture or other obstruction in the urethra. If a stricture is found, it may be rapidly dilated with large sounds, or divulsed. A narrow meatus is to be cut. The urine should then be drawn with a catheter, the bladder should be washed out, and borax-water or a solution of boracic acid should be introduced in sufficient quantity to distend it, and so keep its walls out of harm's way during the crushing of the stone. From four to six ounces is usually a proper quantity. An elastic rubber tube may then be tied lightly around the penis, close to the corona glandis, to prevent the escape of water along side of the instrument. This fills the double purpose of keeping a known quantity of water in the bladder, and of preventing the wetting of the patient and the bed.

Before each introduction of the instrument the urethra should be filled with liquid vaseline from a syringe, in order to lessen the injurious friction as far as possible.

To introduce the lithotrite properly, the point should be carried with considerable gentleness through the constriction made by the rubber tube, and it then slips without difficulty through the movable urethra. After the beak passes below the pubes, the handle should be brought to a vertieal position, and the instrument will then drop almost without assistance, by its own weight, until the point rests just in front of the triangular ligament. Traction upon the penis now effaces the depression made by the extremity of the instrument in the bulbous urethra, and if the handle is then brought down gently between the thighs and at the same time the point is advanced in the axis of the body, the lithotrite usually slips easily into the bladder.

The places where difficulty may be met in a normal urethra are at the triangular ligament and at the prostate.

The point of the instrument may catch on the upper or lower edge of the comparatively rigid opening of the triangular ligament. If the handle is depressed before the beak of the instrument is carried down as far as it will go toward the rectum, the point is likely to catch against the upper edge of this opening; while, on the other hand, if the instrument is pushed too forcibly toward the sacrum, the lax, bulbous urethra is depressed below the aperture, and the point catches on the lower margin. Practically, if the instrument catches at the triangular ligament, it should be passed down with the beak hugging first the roof and then the floor of the urethra, and in one or the other of these ways it will usually find its way through. The finger pressing against the convexity of the curve of the instrument in the perinæum will often lift the point over the lower margin of the opening when it is catching there.

A similar difficulty may be met with at the opening into the prostate. This happens but rarely, and is to be overcome by the same tactics. In cases of much difficulty the finger introduced into the rectum serves as a good guide, and with it the point of the instrument may be lifted into the prostate when it is catching on the lower edge. An enlarged prostate is, as a rule, easily passed by the lithotrite, whose short, curved beak carries the point along the roof of the canal, where it rarely meets an obstacle.

False passages may make the introduction of instruments extremely difficult and dangerous. Even if by long and patient trial they are finally passed, and the stone is comminuted and removed, the danger is not then over, for a serious swelling of the urethra is likely to follow, and under these circumstances the passage of a catheter is almost an impossibility.

A single false passage, if its position is accurately made out, may usually be avoided by carrying the instruments along the opposite wall of the urethra at this point. If, however, several of these pockets exist, in which the instruments are caught, it will perhaps be a wiser plan to resort to lithotomy, which, though a more severe operation, has the great advantage of providing certain drainage for the bladder.

If the stone is free, it rests upon the floor of the bladder, and, with the patient in a horizontal position, it is usually found at a point a short distance behind the prostate.

The operation of crushing not only demands considerable skill of manipulation, but it is also greatly assisted by an accurate knowledge of the contour of the bladder, and of the changes in shape which may be impressed upon it by varying conditions of the surrounding organs.

Dr. Bigelow, in preparing his work on litholapaxy, made a careful study of these changes. He says: "We get a useful view of the interior of the bladder by examining in position through an opening in its summit. This part of the organ, with the free and thin posterior wall, is mainly concerned in distention. The floor of the bladder is comparatively firm and flat, and, if the subject is in good condition, adheres to a thick mass of cellular tissue in and near the ischio-rectal fossæ, upon which it rests. This mass is traversed by the rectum variously distended; and this canal, in a thin subject, may be advantageously filled with air during an operation, to facilitate its indentation by an instrument—reversing, for the operation of lithotrity, one of the precepts of lithotomy.

"The sigmoid flexure is largely concerned in compressing the bladder behind. The posterior wall of this viscus may be so crowded by the intestines as to become flat, or even concave. A horizontal section of the bladder is then transversely oval, flattened between the intestines behind and the pubes in front, each of these indenting it. A well-filled or tense abdomen tends so to shorten the antero-posterior diameter of the bladder that, while a large stone may gravitate backward into that part of the bladder that is compressed by the intestines, carrying the thin wall with it, it is not so with a fragment, which, unless the floor be artificially depressed, may lie on one side or the other of the vesical orifice more readily than at some distance behind it."

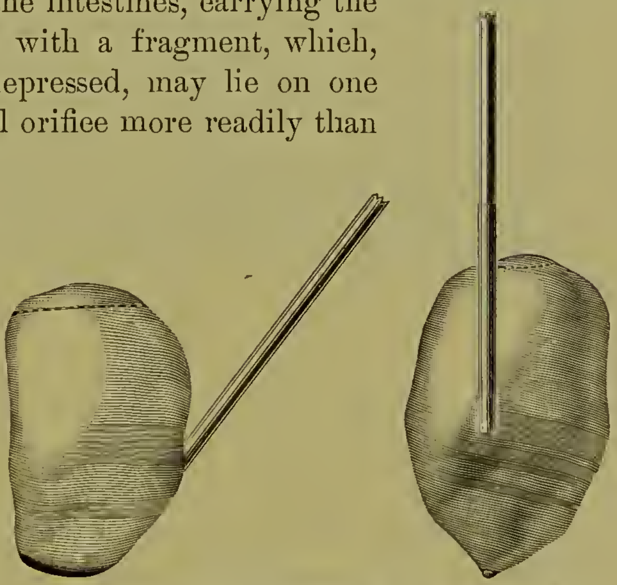

Fig. 48.—Cast of the bladder with an instrument depressing the floor.

A rectum filled with fæces raises and distorts the floor of the bladder, and so not only makes the search for a stone more difficult, but by resisting the indenting of the floor with instruments adds greatly to the difficulty of crushing. It is for this reason that the bowels should be thoroughly emptied before the operation.

If now the lithotrite be introduced and carried to the bottom of the bladder, its beak will make an indentation in which it will rest. Fig. 48 represents a plaster cast of the bladder with an instrument in this position.

As the stone rolls to the bottom of this funnel-shaped depression it rests on or alongside of the beak, and when the blades are opened it falls over the shoe, or female blade, and is therefore seized as the male blade is again closed down.

If this manœuvre does not succeed in catching the stone, the blades should be opened in the upright position, and then turned over on one side and shut along the floor. Care should be taken to always open the instrument in the upright position, for if it is turned on the side and then opened, the male blade pushes the stone or fragments away, and they are not caught as it is again closed.

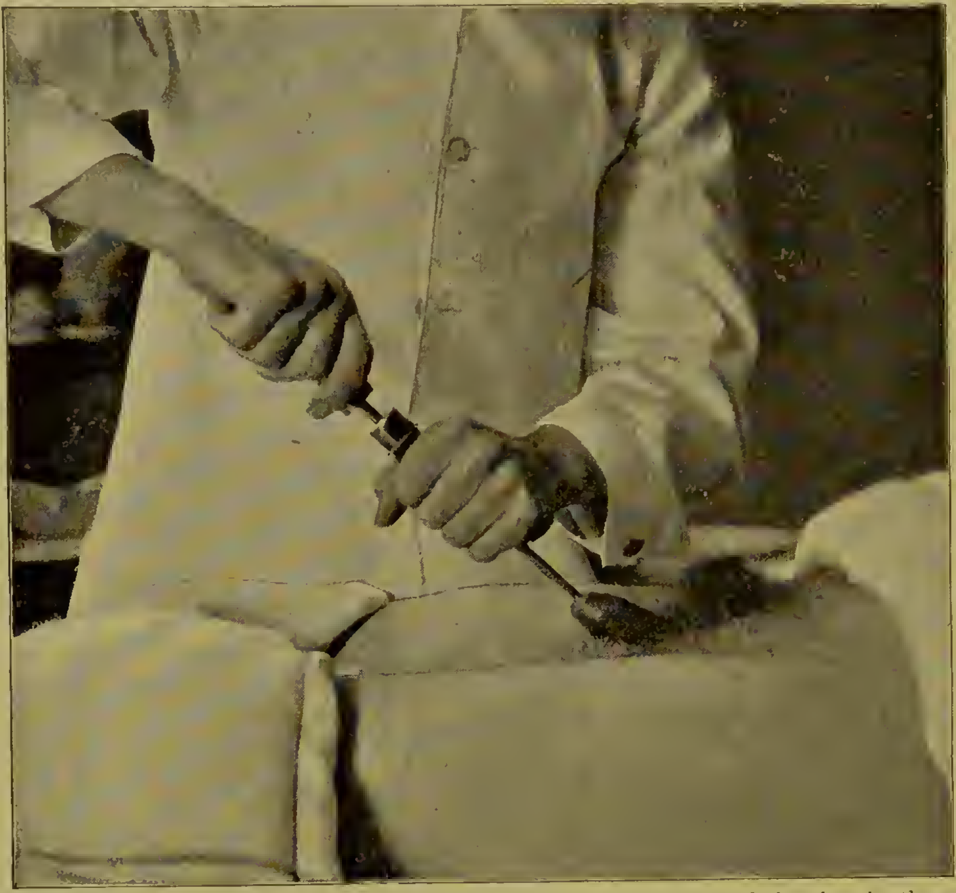

Fig. 49.—Showing the manner of holding the lithotrite when opening and shutting in the search for fragments.

If the stone can not be seized, it may be because it lies in the pouch behind an enlarged prostate, so that the instrument enters the bladder over it. In this case it may be caught by opening the instrument and then turning the blades over so that they point down into the base of the bladder, and shutting them in that position. There is some danger of nipping the bladder wall by this manœuvre, and an easier way of obviating the difficulty is by raising the hips of the patient. This change of position usually rolls the stone out of the post-prostatic pocket into a part of the bladder where it can be easily reached and crushed in the ordinary manner.

When, as rarely happens, the stone is so held in the pouch behind the prostate as not to be easily rolled back, it may usually be displaced by using the closed blades of the lithotrite to pry it out. If this is not successful, it can be pushed up by a finger introduced into the rectum, and if it tends constantly to fall back to a point where it is not accessible, the post-prostatic depression may be effaced by a distended rubber colpeurynter in the rectum, as suggested by Buckston Browne. Mr. Browne met with several cases in which the post-prostatic pocket was a veritable diverticulum beneath an enlarged third lobe, and so concealed the stone that it required a suprapubic operation for its removal.

A stone may be too large to fall into the depression of the instrument, and it is then necessary to depress the handle and so raise the blades, before it can be seized. This sensation of having the stone above the sound or lithotrite sometimes leads to the belief that it is attached to the upper bladder wall, when this is not the fact. In such a case, after the first crushing, the fragments, as they are reduced in size, will be found on the floor of the bladder.

The crushing of the stone should be done as thoroughly as possible at the first introduction of the lithotrite. This saves time and irritation to the urethra, and, with the self-clearing instruments described above, may be accomplished by a little skill and patience in searching for fragments. If the stone is a large one, however, sand and small fragments will presently accumulate and fill up the bottom of the bladder, and then the large fragments lying on top of this *débris* can no longer fall by gravity into the jaws, and they are then not easy to find. When this is found to be the case, it is time to use the pump and clear the bladder of the finer portions. The presence of clotted blood or of thick mucus in the bladder has a similar effect in filling up the depression upon the floor and preventing the fragments from falling into the jaws of the lithotrite. Here, again, the pump is called for.

The form of the female blade, with projecting end and width enough to carry its sharp rim away from close contact with the male blade, makes the nipping of the bladder wall unlikely to occur. This accident is so serious that it should be further guarded against by always, in case of doubt, carrying the blades toward the center of the bladder and slightly rotating them from side to side, to see if they are free, before they are screwed down upon anything that has been seized.

Practically, with the Bigelow instrument, having a floor to the female blade, operating in a moderately distended bladder, the jaws may be safely pressed down toward the trigone and then opened and shut without any fear of catching the bladder wall, so long as they are kept nearly upright. This manœuvre is a valuable one in rapidly reducing the fragments of a soft stone; for no screw-force is required, and the fragments constantly falling on to the female blade are comminuted as rapidly as the instrument can be opened and shut.

It must be remembered, however, that if the bladder is so empty as to fall into folds, greater care must be exercised; and also that, if the instrument is turned toward the side wall, it may perhaps catch a fold, and should be closed with caution. A nip from the blade of a non-fenestrated lithotrite does not necessarily produce a serious lesion of the bladder walls. This accident occasionally happens to every operator without causing troublesome after effects. But the fenestrated instrument with its scissor-like blades, if shut down closely, cuts out the piece of the bladder wall included within its jaws. Especial care should therefore be used in the manipulation of this instrument.

There is also another peculiarity in the working of a fenestrated lithotrite, which should be borne in mind when one is used. It is this: During the early part of the crushing, when the stone breaks and falls apart in the jaws, it is natural to open the lock and again search for a large fragment without fully screwing down. This is a safe manœuvre with a solid instrument, but with a fenestrated one it is important to remember that portions of stone pushed through the female blade will cling to it with some tenacity unless the male blade is thoroughly pushed down through it, and that a rough fragment thus projecting below the blades may do serious injury. Therefore the fenestrated instrument should always be closely shut down on whatever it seizes.

When, finally, no more fragments of any size can be caught, the lithotrite should be firmly screwed together and withdrawn. If there is any difficulty in fully closing it, the jaws may be carried to the center of the bladder, and there with the screw may be opened and shut a few times to work out the impacted stone from between them. This manœuvre is of importance, not only on account of the difficulty of drawing out a partially open instrument, but far more because an instrument not wholly freed of *débris* may have sharp, angular fragments projecting from it which will lacerate the urethra in withdrawal.

We now come to the second part of the operation, the evacuating of the fragments. In selecting the catheter for this, a straight tube should be used, if possible, as it not only affords a straighter and easier road for the fragments, but also is more easily turned in the bladder, when the operator wishes to direct the orifice toward different portions of the viscus.

While the curved tubes are introduced like an ordinary catheter, the straight tube requires a little manipulation. It should be carried down in a vertical direction until it will go no farther toward the rectum. Then, being brought to a horizontal position, it should be gently pushed upward in the axis of the body. At the moment of bringing the tube down between the thighs, pressure should be made over the pubes, pushing the penis downward in order to relax the suspensory ligament. Before advancing the instrument horizontally, it is well to withdraw it very slightly in order to disengage its point from the pocket which it is likely to make in the bulbous urethra. When there is a hitch at the triangular ligament or at the prostate, the tube may usually be carried through by rotation, in the manner of a corkscrew. As all the obstacles likely to be met in the urethra are on the floor, it is usually sufficient to carry the outer end of the straight tube low down between the thighs, in order to enable its point to ride over any obstruction that it meets in the prostate. With care in these regards, it passes readily into the bladder. When, owing to any peculiarity of the urethra or prostate, the straight tube does not pass readily, a tube with the point slightly turned up, after the manner of a *coudé* catheter, may be tried, and if this fails, the curved tube may be used as a last choice.

When the tube has entered the bladder, its point should be carried gently down toward the base, and it should then be connected with the bulb. On opening communication between them, the air contained in the tube will escape into the bulb, and should be driven out through the hose at the top, and its place supplied by water before the operation begins.

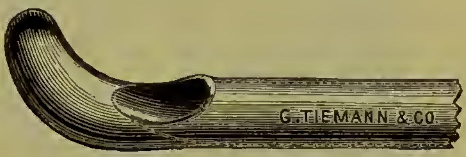

Fig. 50.—Straight tube, with the end turned up to facilitate introduction.

When there is much *débris*, it is well to commence pumping with the point of the tube held a little above the floor of the bladder. During this earlier part of the operation there should be no interval between the compression and expansion of the bulb. The object at this time is to set the fragments whirling, and to catch them while they are suspended. If the end of the tube is buried too deeply in the *detritus*, it is apt to be clogged at the outset, and the evacuation is thereby considerably hindered. Later, when the fragments are few, the tube is carried to the floor of the bladder, and a few moments should elapse, after pressing the bulb, to give the fragments time to settle into the depression about the end of the tube before the expansion which is to suck them into it. When any particular aspiration brings fragments, the position of the tube should be kept unchanged until they cease to come.

The wedging of a fragment in the tube causes an obstruction which is very noticeable. The compression of the bulb is rendered difficult, and its expansion slow. An angular fragment may lodge so that, while it allows the passage of water, it prevents the entrance of other fragments. This condition may be suspected if there is a constant clicking against the tube, and still nothing appears in the reservoir. The usual point where fragments wedge is at the mouth of the tube. When one thus becomes fixed, it may be dislodged with a stylet, and this is the safest method of disposing of it, although with care the tube may generally be drawn out with the fragment in it. This procedure, however, is not devoid of danger, for sharp, projecting angles may lacerate the urethra, or a bit of stone may remain sticking in the passage.

The tube may also be obstructed by the bladder wall, which is sometimes sucked into the orifice. The stoppage from this cause is usually not continuous, but the walls flapping against the opening give the instrument a series of jerks which remind one of a fish-bite. When this is felt the instrument should be moved to another part of the bladder; and, if it then occurs, it shows that the bladder is not sufficiently distended, and water should be added through the hose at the top of the bulb. Pumping should be prolonged until the sand and gravel cease to come. Then the lithotrite should be again introduced and the crushing continued, followed again, as before, by the washing out. Finally, after the stone has been thoroughly crushed, and when for several minutes no fragments appear in the reservoir, it is evident that the evacuation is

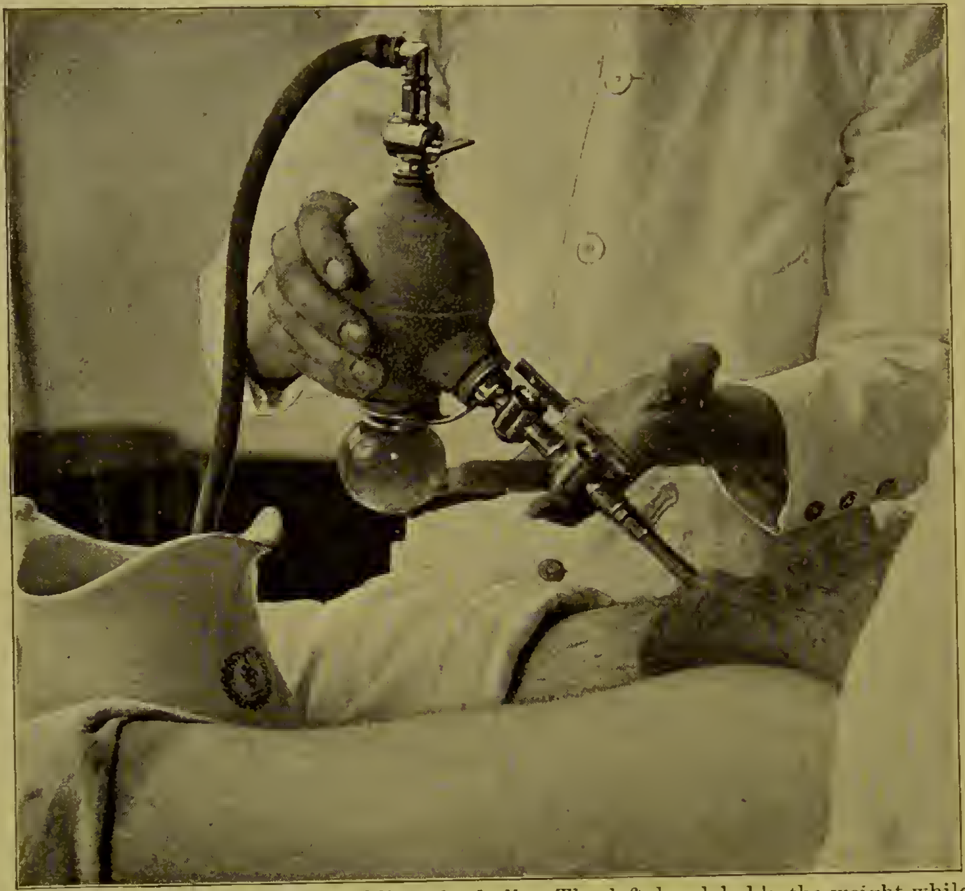

Fig. 51.—Showing the manner of holding the bulb. The left hand holds the weight while the right manipulates it.

almost completed; and now begins a very important part of the operation—namely, the search for the last fragments. The tube should be moved to different parts of the bladder, and the orifice should be systematically turned in all directions in order to wash out any side pockets or corners that have been passed over. The pouch behind the prostate should be especially attended to in this way.

Keyes recommends his tube with open end for the washing out of the last fragments. It requires especial care in its manipulation, and its vesical end must be kept close to the neck of the bladder. If introduced too far, it sucks up the posterior bladder wall uncomfortably; and if drawn out too far, it may bruise the prostate.

It sometimes happens that the last fragment is difficult to find with the lithotrite, and is still a little too large to pass the tube. Great patience is then required in the search for it. I have once or twice succeeded in such a case by drawing the fragment to the tube, and have then dropped it on the floor of the bladder, where the lithotrite readily found it and crushed it.

Chismore has devised a lithotrite which seems admirable for the removal of this last fragment. In it the shaft of the male blade is hollow, the opening being in the heel of the blade. It has an aspirating bottle attached to its upper end, so that when the blades are slightly separated and suction is applied, the fragment is drawn between the jaws and easily crushed on closure of the instrument.

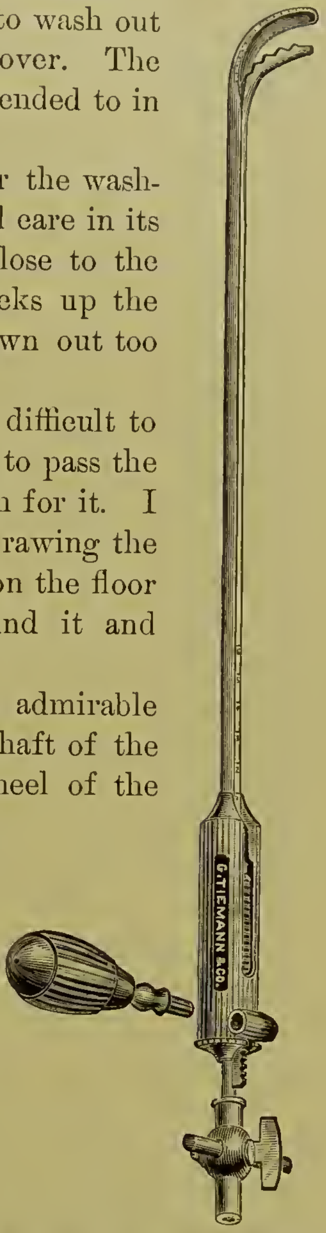

Fig. 52.—Chismore's evacuating lithotrite.

Finally, if after a careful search no more fragments can be obtained and no click of stone against the tube can be elicited, the operation is completed. Before closing, however, it is well to wash out the urethra thoroughly with a catheter of small size, which allows the water to rush out alongside of it. This removes much find sand, which oozes along the lithotrite and lodges in the canal during the operation. The writer adopted this plan several years ago, and he has found, since putting it in practice, that his patients have suffered less from painful, scalding micturition than formerly.

**After-treatment.**—If the patient has been able to urinate normally before the operation, little or no after-treatment is required. It is usually well to allow the patient to drink liberally of water, and to keep him quiet for a few days, although this is often not necessary where the stone is small and has not caused much cystitis. When, however, owing to enlargement of the prostate or stricture of the urethra, the bladder has not been able to empty itself, but requires the aid of a catheter, it is often well to fasten the catheter in for the first few days and thus provide for the drainage of the bladder, and at the same time spare the urethra the irritation of the frequent passing of an instrument. This also may be required when there has been any laceration of the urethra which may lead to swelling and partial closure of the canal.

The cystitis which persists after the removal of the stone should be treated by medication, and, if necessary, by irrigation, as described elsewhere.

It sometimes happens that the bladder becomes partly filled with tenacious muco-pus which does not readily pass with the urine, and which leads to an almost constant desire to micturate, with a sometimes painful tenesmus. This can usually be drawn off through a large, soft catheter, but if this does not succeed, it may require the use of a litholapaxy-pump for its removal.

At the end of ten days, or a fortnight, the bladder should be washed out with an evacuator to remove any sand or gravel that was left at the time of the operation, and which would serve as a nucleus of a new stone. In a sacculated bladder, or where there was much mucus present at the time of the operation, fragments will often be found by the secondary pumping, and in some cases the tendency to the formation of phosphatic material is so strong that repeated pumpings at intervals of ten days will continue to remove little calculi, until the alkaline tendency of the urine has been overcome.

The operator should not be content until he has had a satisfactory washing with the pump without obtaining calcareous material. As a small catheter can be used for the removal of this fine *débris*, the operation is comparatively free from pain, and can be done without anæsthesia.

The operation as just described is the litholapaxy of Bigelow, and it remains to speak of one or two variations of it practiced by good operators and liked by them. The changes introduced are mainly in the methods of accomplishing evacuation.

Chismore's evacuating lithotrite has been described, and its usefulness in the search for the last fragment alluded to. It was originally devised for this purpose, but its inventor has gradually pushed his use of it, until now he employs it in all his operations from beginning to end. The light rubber aspirator that he has attached to it does not interfere with its manipulation as a lithotrite, and does not have to be removed during the crushing of a soft stone. When more power is needed in the crushing, the aspirator is removed and a handle is substituted, which gives a firmer hold and permits of the exercise of more force. When the stone is very hard, he uses an extra strong male blade with a lock and screw.

Some operators use the elasticity of the bladder walls to accomplish the evacuation of the fragments. Guyon introduces the evacuating catheter and lets the fluid in the bladder rush out, bringing what fragments it can with it. He then with a syringe fills the bladder and again empties it with a rush. After repeating this a number of times and removing as much as possible, he then uses the aspirator to pump out the last fragments.

Keith has recently reported satisfactory results obtained without the use of any aspirator whatever, and seems to have removed many large stones simply by filling and emptying the bladder. He speaks of no cases of rupture of the bladder due to the forcible injection. His practice has been in India, and possibly his patients have been somewhat younger than is the rule among stone patients in other countries. This would account for his finding sufficient resiliency in their bladders to accomplish evacuation in this fashion. Among old patients with atonied bladders it would not seem possible to expect such results.

I have tried this method in a somewhat modified form, after a manner proposed by Dr. F. H. Williams a number of years ago. By means of a two-way cock attached to the end of the catheter, it was arranged so that water could be at will run into the bladder and then run out through a tube over the side of the table. In this way we had a siphon action drawing the fragments from the bladder, in addition to the elasticity of the bladder driving them. The injection of water into the bladder was provided for by a tube connected with the upper opening in the two-way cock and joining it with a raised reservoir. This reservoir was a transparent graduated glass, and thus at each filling of the bladder the operator could see exactly how much water had flowed in, and could judge of the tension by noticing the rapidity of the fall of water in the reservoir. The apparatus was easily and quickly worked by alternately turning the current to and from the bladder.

In the case upon which this was tried the amount of *débris* was great, and the bladder was dilated and atonied. The clogging of the tube was troublesome, and the outrush was not forcible enough to carry the detritus along in any large amount. After trying this method for a time, I substituted the Bigelow evacuator, with the result of a greatly increased rapidity in the removal of the fragments.

## COMPLICATIONS WHICH MAY ARISE DURING LITHOLAPAXY.

Among the accidental conditions which may arise during a litholapaxy may be numbered the following: Hæmorrhage, laceration of the urethra, injury of the bladder walls, impaction of a fragment in the urethra, and clogging, bending, or breaking of the lithotrite.

**Hæmorrhage.**—A slight or moderate amount of bleeding not uncommonly accompanies the operation. It may come from the urethra or bladder. More commonly it is due to the injury done to the congested prostatic urethra, and it is more likely, therefore, to be seen in old men. When the blood comes from the urethra anterior to the prostate, it rarely causes any trouble, and soon ceases. Blood from the prostate runs back into the bladder, and, clotting there, may interfere with the crushing of the stone. It is readily sucked out through the evacuating tubes of ordinary size, and the bleeding usually ceases, or diminishes after the first few minutes. If it continues to be troublesome, the injection of hot water (115° Fahr.) may be tried.

The bladder walls rarely bleed much, unless seriously diseased or injured. A hæmorrhage of any amount in the vesical cavity leads, therefore, to a strong suspicion of the existence of a tumor, and in such a case the washings from the bladder should be carefully saved and examined for bits of new growth. If these were detached and recognized during the operation, the plan of procedure would naturally be changed, and a suprapubic incision would be resorted to. Keyes mentions one case in which, in a bladder not containing a tumor, the loss of blood was so great as to lead to the temporary abandonment of the operation. Subsequently, when the fragments remaining were washed out, there was very little hæmorrhage.

In patients of a hæmorrhagic diathesis the operation would naturally be approached with a good deal of hesitancy; but I have seen no account of serious trouble from this cause.

**Laceration of the Urethra** may be caused either by the introduction of the instruments or by the withdrawal of them when clogged with projecting sharp fragments. In skillful hands an uninjured urethra ought not to be torn during the introduction of instruments of a proper size. An ulcerated or partly strictured canal may be torn even when due care is exercised. It is a good safeguard against this accident to pass a conical steel sound one or two sizes larger than the lithotrite and tubes. This gently stretches the canal, so that the rougher, pointed instruments are afterward less likely to catch. In the event of having troublesome false passages, either pre-existing or made at the same time of the operation, the surgeon may wisely decide to change the plan and do a lithotomy.

The withdrawal of a clogged lithotrite or of a tube holding an impacted fragment may considerably lacerate the urethra. When this occurs, the ragged tear offers a favorable surface for septic or urinary infiltration, and this accident adds, therefore, considerably to the danger of the operation. This danger is lessened if the urethra is thoroughly washed out with an aseptic solution at the end of the operation.

Whenever so much injury of the urethra results as to lead to the fear of urinary absorption, or of retention from swelling, it is well to fasten in a catheter for the first two or three days. This is especially desirable in a case requiring catheterization, or when a long and tortuous prostatic urethra has been thus injured. Usually, with this precaution, lacerations of the urethra do not lead to serious consequences, especially if antiseptic precautions have been carefully observed in the instrumentation, and if the urine has been rendered aseptic before the operation.

**Injuries of the Bladder** may be caused by catching the walls in the lithotrite. This may usually be avoided by keeping the bladder moderately distended with water during the crushing, so as to prevent its wall from being thrown into folds which might be caught in the jaws of the instrument. The care in the use of the lithotrite which is necessary to avoid this accident has been described in considering the operation. It is conceivable that in a diverticulated or chambered bladder the female blade of the open instrument might find its way into a pocket, or chamber, while the male blade remained in the general cavity, and the intermediate septum would then be caught as the instrument was closed. I have seen bladders in which this might have easily occurred, and have twice during litholapaxy in old men had my instrument so caught and held that I thought it must be thus held in a pocket; and finding, on trying to close it, that a soft resistance was met, I kept the blades partly open, and then, keeping the shaft nearly upright, carried the heel of the instrument close down behind the neck of the bladder and thus was able to close it. In both cases, by operating near the neck of the bladder, I was able to finish the crushing and evacuation of the stone. Fortunately, injury of the bladder walls by nipping is usually followed by no untoward results.

Another accident which may happen to the bladder walls is the rupture of them during litholapaxy.

**Rupture of the Bladder Walls.**—This may result either from using the pump when the bladder is too full, or from spasmodic contraction of the bladder when the urethra is blocked with instruments. Great care should be taken, when injecting the bladder before the operation, to notice the degree of resistance which it offers to the entrance of the water. This is especially important if the escape of the water alongside of the instrument is prevented by an elastic band. The force required to rupture an undiseased bladder wall is so great that this is very unlikely to occur; but as many of these bladders are diverticulated in old people, there is considerable danger to the thin-walled diverticulum.

I have had one such case, in which a bladder ruptured itself by its own spasmodic contraction when containing but an ounce or two of urine. In this case a laparotomy was done at once. It was found that the rupture had taken place extraperitoneally on the left side, and the urine had escaped into the cellular tissue up toward the kidney on that side. Drainage was established in the left groin, and the case eventually got well.

Whenever, during the litholapaxy, the bladder is affected by violent spasms, the operation should be delayed until the anæsthesia is so profound as to put a stop to these. If this is found impossible, it may even be necessary to do a lithotomy rather than run the risk of rupture. When a spasm occurs during the pumping, it can be at once relieved by opening the stop-cock at the top of the bulb, and letting out the excess of water.

**Impaction of Fragments in the Urethra.**—Occasionally, as has been said, fragments lodge firmly in the eye of the evacuating tube, and the temptation is strong to try to draw them out with the tube. This attempt usually succeeds, but, besides its scratching the urethra, there is danger that the fragment may be dislodged from the tube and remain sticking in some part of the canal. Also, if the bladder is contracting strongly, a fragment may be forced into the urethra at the time of withdrawal of some of the instruments.

The points of usual arrest of fragments are in the prostate, at the triangular ligament and just behind the meatus. From this last situation fragments are usually removed by incising the meatus and using forceps. A fragment lodged in the prostate may often be pushed back into the bladder with a large, blunt-pointed sound. When the bit of stone lodges in the urethra just anterior to the prostate, it may be very difficult of removal. In a recent case, where a fragment was dropped by the tube in the membranous urethra, I succeeded in pushing it back into the bladder by the following manœuvre: Passing a straight tube with a long under lip (Fig. 50) down to the fragment, I then introduced the finger into the rectum, and, while lifting the bit of stone, worked the lip of the tube under it, so catching it in the mouth of the tube and readily pushing it back into the bladder. (For further consideration, see Urethral Calculi.)

**Clogging and Breaking of the Lithotrite.**—The strong modern lithotrites of the Bigelow pattern do not easily become clogged. A tough foreign body, as the nucleus of a stone, may, however, resist complete crushing and become entangled in their jaws. I have met one case in which a leather shoe-string formed the nucleus of a stone, and became so fixed in the jaws of the lithotrite as to make a very considerable mass to be drawn out with it. Though the urethra was much rasped by its passage, no ill effects followed. It is conceivable that in some such way the jaws of an instrument might be so held apart that they could not be withdrawn without great violence. Under such circumstances the blades should be carried to the center of the bladder, where there is no danger of catching the walls, and should there be many times opened and shut with the screw in order to gradually grind up or cut through the offending body.

If a lithotrite is tested outside of the bladder on a hard stone, it will be found that its blades are often twisted considerably during the crushing, but being of well-tempered steel, they spring back into correct shape when the pressure is taken off. With a small instrument suitable for a child, this twisting is often very great, and it may happen that the resistance of the metal is overcome, and the jaws are so distorted as to be afterward difficult of withdrawal. Usually, however, they break rather than bend. A number of cases of this accident have been reported. The fracture may occur at the heel of one of the blades, or on the shaft of the female blade, a short distance above the bend.

This last point is the position of the greatest strain in crushing a large stone, for the obliquity of the blades causes the force against the female blade to act rather downward, so that there is greater leverage exerted upon the shaft above than at the heel of the blade. When a hard stone is encountered, which resists all the force that it seems safe to apply, it is best, after cutting into it somewhat in one diameter, to seize it in a new place. It thus presently becomes weakened and gives way.

The breaking or serious clogging of a lithotrite may oblige a resort to lithotomy. A perineal incision will usually give room enough for the extraction of a broken blade, or for the clearing of a clogged instrument. If the perinæum is very deep, or the prostate large, the suprapubic route will probably be preferable, and, in case of a twisted or distorted instrument, the high operation gives more room for the exercise of force sufficient to bend the blades back into place.

## COMPLICATIONS AFTER OPERATION.

Hæmorrhage rarely causes trouble after litholapaxy, except that, in cases requiring the use of a catheter, this may be plugged by the clots. It may be necessary to free the bladder by the evacuator, if ordinary injections and irrigation fail to bring them away.

**Epididymitis** occasionally follows an operation in which the prostate has been much irritated. The only case in which I have seen epididymitis follow the operation was one in which the urethra was considerably scratched by a rough fragment which was drawn out in the eye of the evacuating tube.

**Urethritis, Prostatitis, and Cystitis.**—Inflammation of the urethra, of the prostate, or of the bladder, may follow a litholapaxy. In fact, such conditions existing before the operation may be temporarily aggravated by it. The treatment of them is considered in another part of this work, and does not require special attention here.

**Urinary Fever** is a complication to be occasionally expected, especially in those cases in which the kidneys are gravely affected, and something has been already said in regard to the best prophylactic measures to be taken against it.

**Phlebitis.**—Rarely, an inflammation may extend from the small venous sinuses about the neck of the bladder to neighboring large trunks. I have had one case in which the left leg was swollen and tense from this cause. The patient was a middle-aged man, who made a good recovery from an operation for the removal of a hard uric-acid calculus of considerable size. Fourteen days afterward he was on the lounge, and the bladder was washed out with the pump without ether. This caused him rather more pain than usual, though no difficulty was experienced in the manipulation. A few hours later he was seized with severe pain in the left leg, which at once began to swell, and ran the ordinary course of a rather extended phlebitis of the femoral vein.

**Treatment after Litholapaxy.**—After an uncomplicated litholapaxy, in a case with reasonably sound urinary organs, the relief is often immediate and the recovery uneventful. It is well, however, even in such a case, to keep the patient quiet in bed for a few days, as the urinary organs are often slow to show inflammation, and a febrile condition may set in on the second or third day after a litholapaxy, when up to that time everything has seemed to go smoothly.

Usually some pain and febrile reaction follows the operation. Hot applications to the hypogastrium and perinæum will do something to relieve the pain. The treatment commenced before the operation to render the urine aseptic may be continued, and for a diuretic the free administration of spring-water is usually sufficient.

If there is a tendency to retention of urine, and the bladder empties itself incompletely, the catheter must be used. Mucus and irritating ammoniacal urine must be removed by irrigation, with appropriate solutions of borax, permanganate of potash, or nitrate of silver. If there is a tendency to phosphatic deposit, it must be met by injections of dilute nitric acid, and by the occasional use of the evacuator to remove granules too large to be destroyed by solvents.

Other complications must receive appropriate treatment.

At the end of ten days or a fortnight, when the irritation caused by the operation has subsided, the evacuator should be used, to make sure that there are no retained fragments or sand. At this time, after the mucus has largely disappeared from the urine, it is surprising how easily fragments are removed which escaped the most diligent search at the original operation.

## 3. Lithotomy.

The cutting operations by which stones are removed from the bladder naturally divide themselves into two classes:

1. The perineal operations, in which the incision approaches the bladder along the urethra and enters it through its neck.
2. The high, or suprapubic operation, in which the incision is made in front above the pubes, and the bladder is opened through its anterior wall just above the prostate.

### PERINEAL LITHOTOMY.

The perineal route is a comparatively long one and beset with anatomical difficulties, consequently the ingenuity of surgeons has been much exercised in devising methods by which the dangers may be avoided and at the same time the most room may be obtained.

Of these methods and modifications we will consider those which have had sufficient merit to retain a place in modern practice.

The space in the perinæum within which the lithotomist must work is bounded by the rami and tuberosities of the ischia, and posteriorly by the sacro-ischiatic ligaments.

The structures within this space which the knife must avoid are the internal pudic arteries, which lie close to the tuberosities and rami of the ischia ; and the rectum, which lies in the middle line just below or behind the centre of the pelvic outlet. It is also well to avoid an extensive incision into the bulb of the urethra, as its spongy tissues sometimes bleed in a troublesome way.

The field of possible operation is therefore a crescentic one, encircling the rectum anteriorly, coming well down on each side, and extending back even to the sacro-sciatic ligaments. Within this space all the external incisions may be made safely. As we approach the bladder we reach more important structures, which may not be incised so freely.

The early Marian operation contemplated an incision into the body of the bladder, and the effort at that time was to avoid the neck of the bladder, if possible. It was found, however, that this was a needless fear, and the introduction of the grooved shaft as a guide for the knife led the incision directly through the neck of the bladder. This practice soon demonstrated that the prostate could be freely incised, and the belief gained ground that the danger of the operation was considerably increased when the deep incision reached beyond the prostate and opened the loose cellular spaces behind it, thus preparing the way for urine infiltration.

Thompson, while accepting the general truth that the incision should remain within the prostate when possible, points out the fact that in children, before the prostate is developed, these spaces are opened, and yet that urine infiltration is rare; and he urges that the deep incision should be sufficiently free to permit the removal of the stone without bruising the tissue, even if the limits of the prostate are overstepped. Another disadvantage in carrying the incision into the bladder wall behind the prostate is that the seminal vesicles may be injured. It may be regarded then as a proper matter for attention during the operation to keep the deep incision within the prostate, if possible.

There have been in recent times various attempts to get more room for removing large calculi through the pelvic outlet by carrying incisions through the rectal wall into the bladder. Some of these contemplated openings through the prostate, while in others it was intended that the trigone should be incised. These recto-vesical operations, although they gave much room, had, however, a high rate of mortality; and since modern improvements have made the supra-pubic operation a safer method for the removal of large stones, they have no longer any title to surgical consideration.

The perineal operations which are still more or less in vogue are the *lateral*, the *median*, the *medio-lateral*, and the *medio-bilateral*.

## ANATOMICAL CONSIDERATION OF THE VARIOUS INCISIONS.

**Lateral Lithotomy.**—In this operation the space in the left half of the perinæum is utilized for the incision. The knife enters the perinæum just to the left of the raphé, at a point an inch to an inch and a quarter in front of the rectum, and is carried backward over the ischio-rectal fossa. The urethra is opened in the membranous portion, the knife then enters the bladder along the urethra, and the incision in the prostate is made out through the greatest diameter of the lateral lobe.

Thompson has pointed out the fact that the incision in the prostate does not follow the oblique downward direction of the external incision, but runs more horizontally.

The parts divided in a typical lateral operation are the skin and superficial fascia, the transversus-perinei muscle, the posterior portions of the accelerator-urinæ muscle, the membranous-urethra and the compressor-urethræ muscle, the anterior and posterior layers of the deep perineal fascia, and the left lateral lobe of the prostate. In the child, who has practically no prostate, the body of the bladder is incised.

The vessels and nerves that are cut are of little importance, the transverse perineal artery being the only blood-vessel of appreciable size that is necessarily divided.

If the incision is carried too far forward, the bulb of the urethra or the artery of the bulb will be cut, and may give rise to troublesome hæmorrhage deep in the wound. The pudic artery is usually so far out under the ischia that it can only be injured as the result of carelessness; but cases are reported in which it runs across the field of operation, and is necessarily wounded. Occasionally, too, the artery of the bulb starts farther back than usual, and so runs directly across the line of incision. The hæmorrhoidal veins, or the venous plexus about the prostate, may be much dilated in old men and bleed profusely.

The rectum, if distended with fæces or flatus, may encroach on the line of incision, but, if empty, is easily avoided. In case of a large stone that will not pass through the opening provided by this incision, it may be somewhat enlarged. The narrow part is not in the lax outer tissue, but in the neck of the bladder, and with the object of gaining more room here, the incision may be carried beyond the prostate, or a second incision may be made into the other lobe.

**Bilateral Lithotomy.**—The bilateral operation consists in an incision curved crescentically in front of the anus, with the concavity looking backward. It crosses the raphé at the point where the lateral incision begins, and the tissues divided are the same as in the lateral operation, with the difference that the similar structures are divided on both sides of the middle line, and the ends of the incision are not carried so far back over the ischiatic fossæ. The opening into the prostate is made by simultaneous incisions into both lateral lobes, for which part of the operation Dupuytren devised his double *lithotome caché.*

**Median Lithotomy.**—In this operation the incision is made on the raphé immediately in front of the rectum, and the parts divided are the skin, the superficial fascia, fibers of the accelerator urinæ and of the sphincter-ani muscles, the membranous urethra, and the two layers of the deep perineal fascia. The prostate is incised in its posterior commissure. In the case of a small stone or a foreign body, it is sometimes possible to get sufficient room for its removal by simply dilating the prostatic urethra. Dolbeau, when devising his apparatus for perineal lithotrity, tested the dilatability of the prostate, and found that it could be stretched to a diameter of from twenty to twenty-four millimetres without tearing. Keyes has verified these figures. It is therefore possible to extract through the uncut prostate a foreign body which, with the forceps holding it, does not measure quite an inch. Anything larger than this will cause tearing; and it is better to make an incision and thus divide the tissues without violence, rather than to make bruised lacerations, with the chance that they may occur in unfortunate directions. The median operation affords but little room at best, and Reynaud combined the median incision through the skin and superficial tissues with a lateral incision in the prostate (medio-lateral operation).

**Medio-bilateral Lithotomy.**—Civiale, with the object of still further enlarging the opening, devised the medio-bilateral operation, in which, through a median opening, the prostate is enlarged bilaterally.

**Selection of Incision according to the Size of the Stone.**—In making choice of a perineal incision for the removal of a stone, we have only the median and lateral operation to consider, including under the median those modifications of the incision through the prostate, either unilateral or bilateral, which are designed to give more room. The other methods of incision, such as the bilateral, the pre-rectal, or the recto-vesical, have all fallen into disuse, and may be left out of the present consideration.

The median operation, while it best avoids injury of important structures and is therefore the safest operation, gives the least room. Dolbeau, as has been said, found that dilatation could be carried to a diameter of one inch. A median incision in the prostate increases this possible diameter somewhat, and with a lateral or bilateral incision considerable room is gained. The stones, however, which can be removed through this opening are all of them of a size to be easily managed by litholapaxy. Under exceptional circumstances, when a digital examination of the bladder is desired, or when drainage for the relief of a long-standing cystitis is planned as one result of the operation, the median incision may be used, and through it a stone or foreign body, having a diameter in two directions of not more than one and a half inch, may be removed.

The lateral operation gives a much larger and more distensible opening, and the incision into the bladder may, when necessary, be carried outside of the prostate with more safety than can be done by the median incision. If through a median incision the limits of the prostate are overstepped and the spaces behind it are opened up, the drainage of these cellular interspaces is not readily accomplished through the opening in the skin; whereas, if the same spaces are opened up in a lateral operation, the dependent character of the external wound does provide good and sufficient drainage to these same cellular spaces.

Very large stones have been removed through the perineal incision. Keyes calculates that a stone two inches in diameter may be drawn through a prostate which has been incised bilaterally; but that, when a stone larger than this is removed, the incision must extend into the body of the bladder. These figures may be somewhat increased in cases of enlarged prostate, where more room is afforded within the body of the gland.

If the operator, having entered upon the perineal operation, finds a stone more than two inches in diameter, it is better to crush the stone and remove it piecemeal, rather than to make extensive incisions into the bladder wall. It is always to be remembered, however, that a clean incision which allows of the easy removal of the stone is less dangerous than a smaller opening through which the stone or its fragments have to be dragged with considerable force. As in the case of the median operation, the stones which are suitable for lateral lithotomy are usually suitable for litholapaxy, unless some special condition makes a cutting operation advisable.

If a stone is too large for perineal removal—and any stone over two inches in diameter may be considered so—*the suprapubic incision* may be selected. Through an opening above the pubes, stones of any size which may form within the bladder may be extracted. Although, when all cases are taken into consideration, the statistics of the high operation show it to be more dangerous than the perineal incision, if the statistics of the removal of large stones through the perinæum and above the pubes are contrasted, the advantage is found to be vastly in favor of the high operation. So true is this that if an operator, beginning with the perineal operation, finds a stone so large that great force is evidently needed for its extraction by that route, he will give his patient a better chance by changing his plan of operation and making the suprapubic incision, using afterward the perineal wound for drainage, if it seems desirable.

## DESCRIPTION OF THE DIFFERENT OPERATIONS.

**Perineal Lithotomy.—Lateral Operation.—Instruments required.**—The difficulties which the surgeon may encounter in this operation are so manifold, that it is important that he should be thoroughly familiar with the use of instruments and appliances suitable for all cases. The following instruments are those with which the surgeon must be provided, and with the use of which he must be familiar when undertaking a lateral lithotomy.

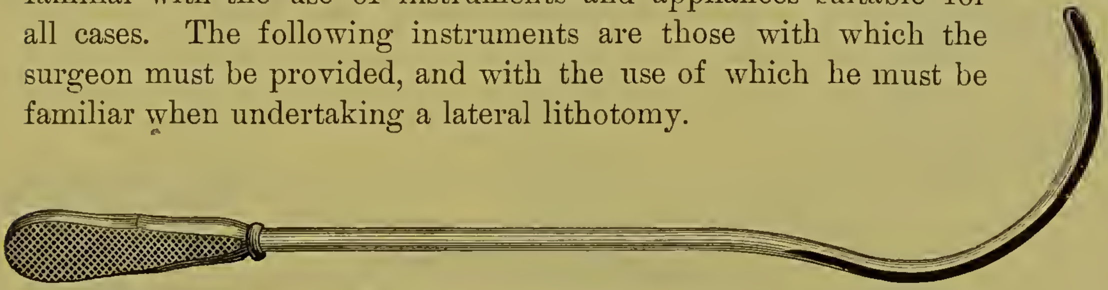

Fig. 53.—Grooved lithotomy-staff.

(1) *The Staff.*—The staff should be grooved on its lower side, and may either be curved like an ordinary catheter, or may be made more in the form of a hook, so as to bulge somewhat in the perinæum. It should be broad enough to be readily found, and the groove should be so deep that the knife can not easily slip out of it.

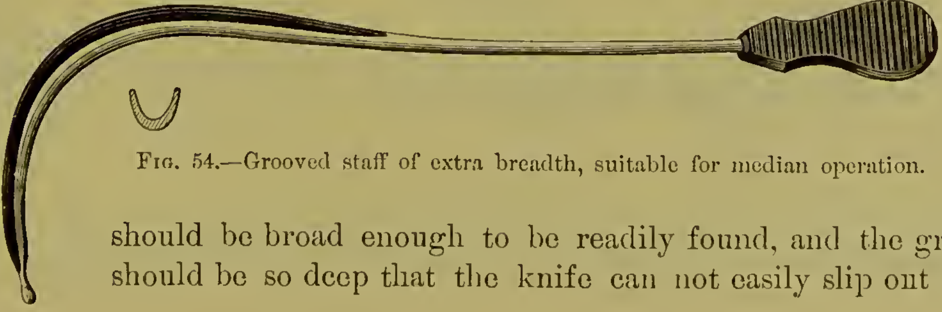

Fig. 54.—Grooved staff of extra breadth, suitable for median operation.

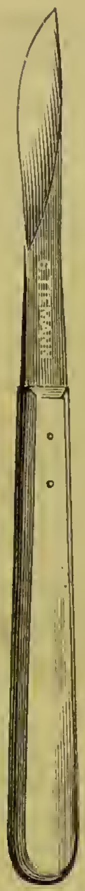

FIG. 55.

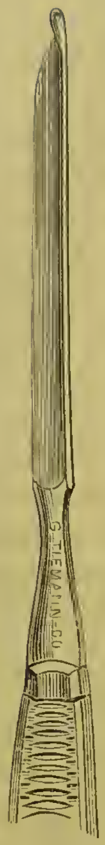

FIG. 56.

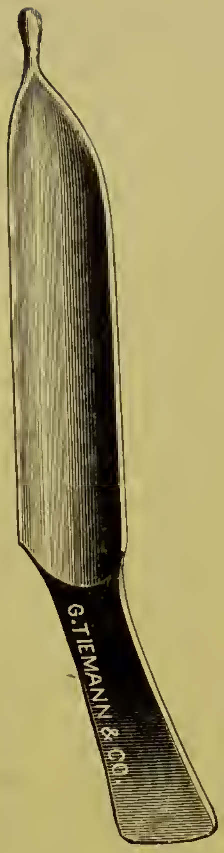
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FIG. 57.

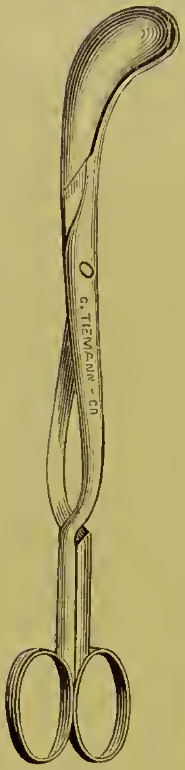

FIG. 59.

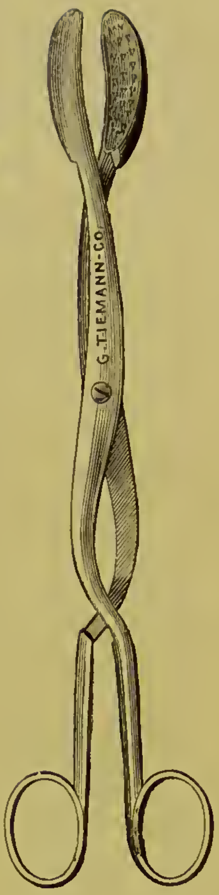

FIG. 60.

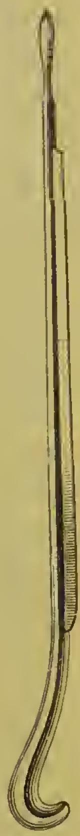

FIG. 61.

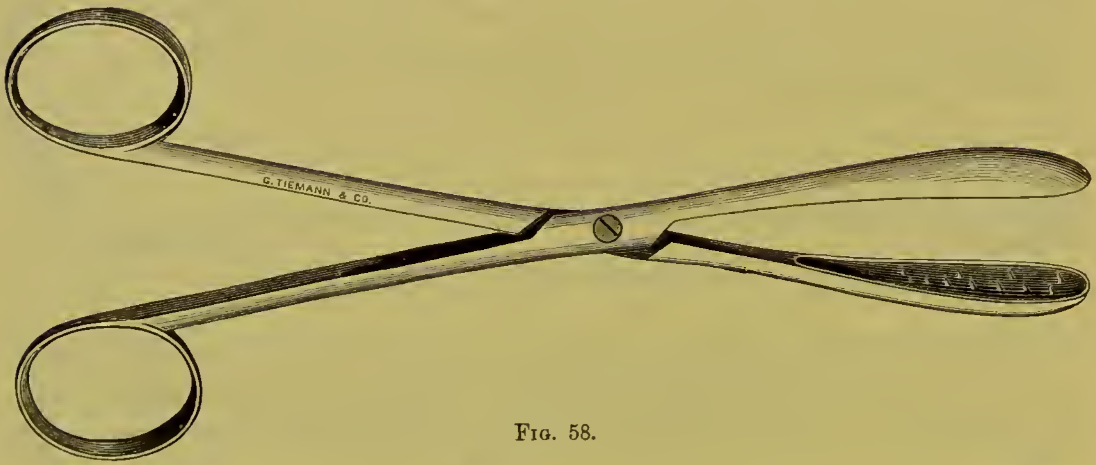
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FIG. 58.

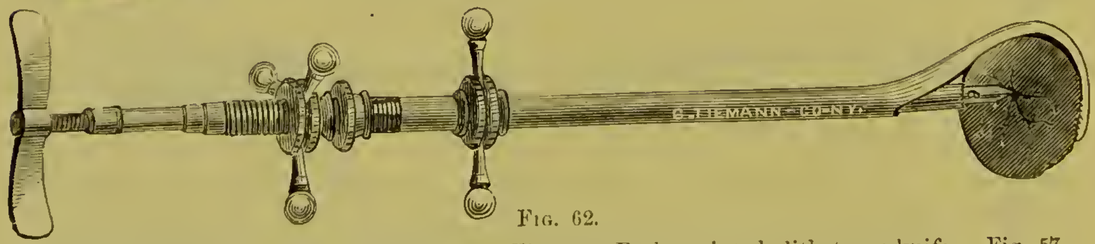
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FIG. 62.

FIGS. 55–62.—Fig. 55. Lithotomy-knife. Fig. 56. Probe-pointed lithotomy-knife. Fig. 57. Blunt gorget. Fig. 58. Lithotomy-forceps, straight pattern. Fig. 59. Lithotomy-forceps, curved. Fig. 60. Lithotomy-forceps for deep perinæum. Fig. 61. Crested lithotomy-scoop. Fig. 62. Maisonneuve's lithoclast.

Some operators prefer a lateral groove in the shaft, but this is not at all essential.

(2) *The Lithotomy-Knife.*—This should have a more solid handle than the ordinary scalpel, with a blade from three to three and a half inches in length. Besides this, it is well to have a second knife of similar shape, but with a probe point, for use in case it is necessary to enlarge the incision after the bladder has collapsed. Thompson also advises a blunt gorget for dilating the incision in those cases in which the perinæum is so deep or the prostate so large that the finger can not reach the bladder. In these cases the groove of the gorget serves as a guide for the forceps.

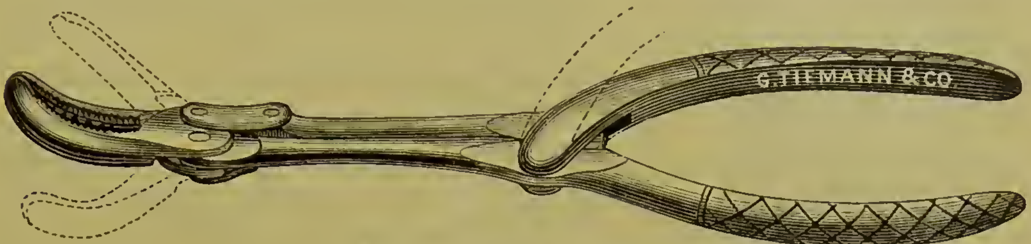

Fig. 63.—Gouley's lithoclast.

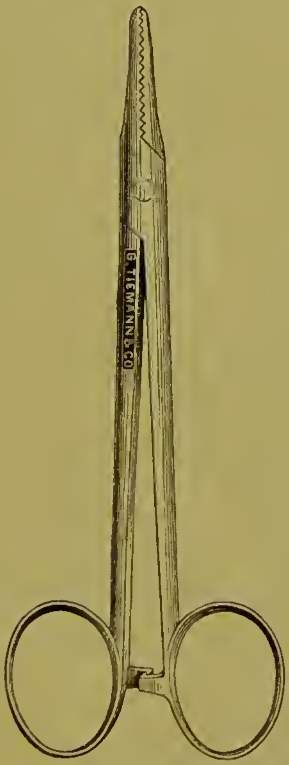

Fig. 64.—Artery pressure-forceps.

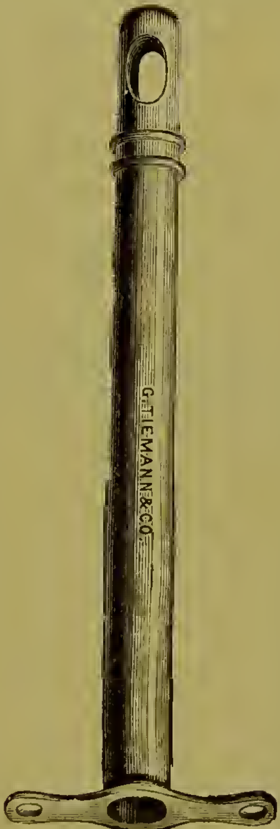

Fig. 65.—Chemise cannula.

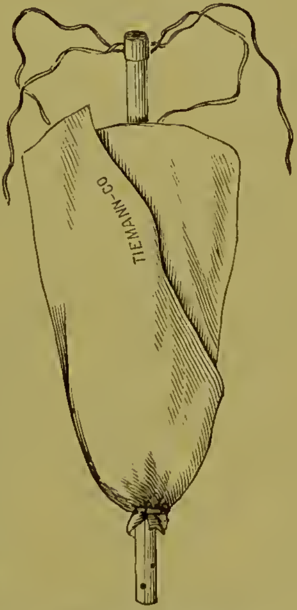

Fig. 66.—Cannula with chemise attached.

(3) *Lithotomy-Forceps* should be of various sizes and different curves. The straight forceps are usually sufficient for cases in which the bladder is of normal shape and size; but in old men, where there is likely to be a pouch behind the prostate, or when the stone lies to one side of the vesical neck, a somewhat sharply curved pair of forceps may be useful. When the perinæum is deep, it is well to have a pair of forceps the handles of which shut by each other, so that the blades can be well opened without widely separating the handles.

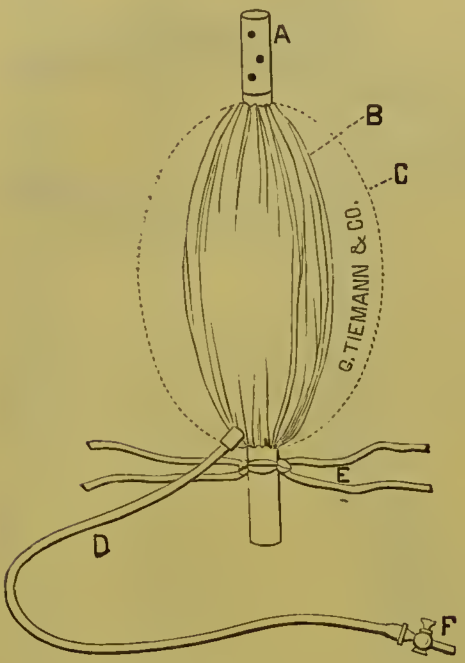

FIG. 67.—Browne's air-tampon and cannula.

(4) *The Scoop* should also be at hand for prying the stone out of a pocket, or for removing fragments too small to be easily seized by the forceps.

It is well also to have crushing instruments of sufficient strength. Many ingenious special forms of instruments have been devised for this purpose, but a strong lithotrite would usually be sufficient. The use of these instruments will be considered under perineal lithotrity.

For washing out *débris*, a large tube should be provided. To check hæmorrhage, pressure-forceps are useful; and Thompson advises the occasional use of a tenaculum which can be detached from its handle and left in the wound, if necessary. This is to be used by hooking up deep vessels upon it, and then tying a ligature firmly around it and leaving the tenaculum in place.

For stopping oozing which does not come from vessels of a size to be easily tied, a chemise cannula is useful, or Buckston Browne's air-tampon.

**Preparation for the Operation.**—The general preparation of the patient has been considered, and the importance of examining into the activity of the kidneys has been pointed out. It is especially important to render the urine as aseptic as possible, as foul, putrid urine may do harm when coming in contact with freshly wounded tissues. It is to be supposed that the surgeon has informed himself as to the special circumstances surrounding his case; that he has determined the size of the stone as far as possible; that he knows the size of the prostate and the depth of the perinæum. The condition of the urethra is also of importance; and it is well to know whether the bladder is closely contracted about the stone, or whether it is readily distensible. That the rectum should be emptied and collapsed so as to be readily avoided, has been said.

The perinæum should be carefully shaved and thoroughly disinfected on the day before the operation, the corrosive poultice being afterward applied and continuously worn up to the time that the patient is on the table.

A suitable strong table should be provided, and, if possible, this should be from two to two and a half feet wide, so as to allow the assistants to stand closely upon each side of the patient. The chair of the surgeon should be of a height to bring the upper part of his chest opposite the patient's perinæum. A tub should be placed at the end of the table, and a rubber cloth should be so arranged that, when the patient is brought down to the end of the table for operation, it shall conduct the blood and fluids into the tub. A convenient rubber apron has been devised for this purpose.

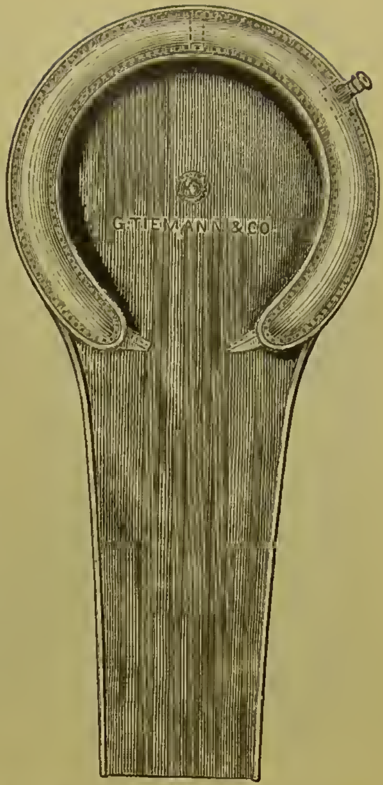
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FIG. 68.—Rubber apron to be put under the hips.

Enough assistants should be provided to give the surgeon all the aid that he requires. One assistant administers the ether, and one is essential to the care of each leg. To the one holding the patient's left leg can be intrusted the care of the staff. It is well to have a

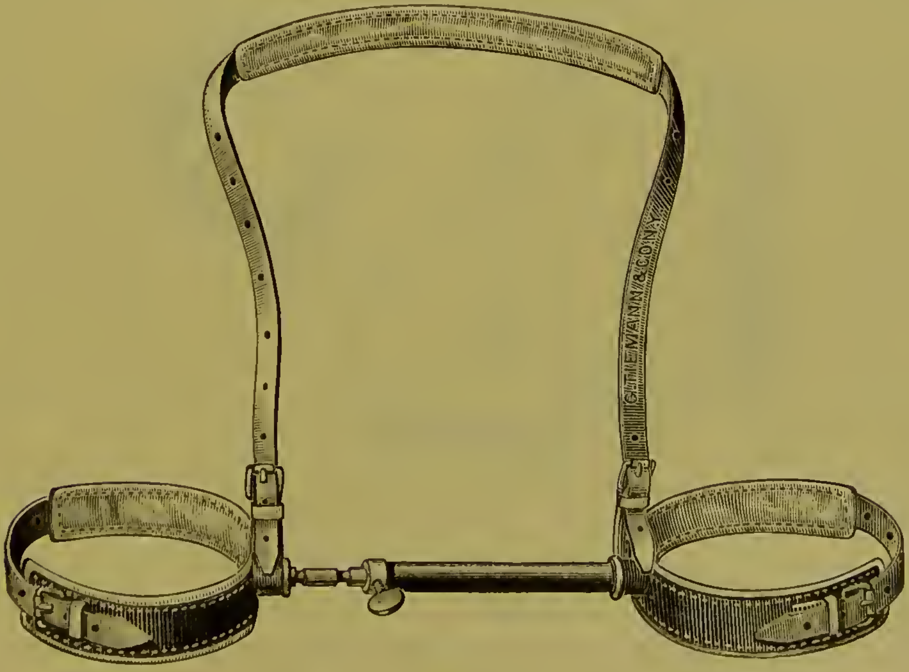
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FIG. 69.—Bar to hold the legs, with strap to go over the shoulders.

fourth assistant, to give the surgeon such aid as is required; but if one is not forthcoming, the one holding the patient's right leg can sponge and give all the help that is absolutely necessary.

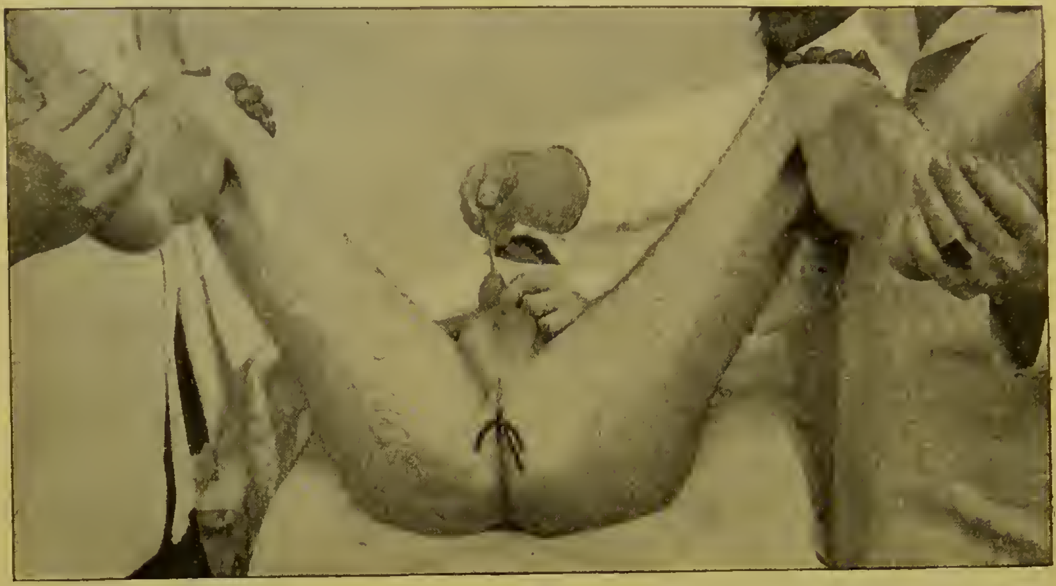

Fig. 70.—Patient in lithotomy position, with the staff correctly held. The lines of incision for the median, the lateral and the bilateral operations are marked.

The instruments should be on a table at the right hand of the surgeon, within easy reach.

It being important to hold the patient steadily and firmly after he is once in position, it is well to provide a bar to go between the legs, with a crutch at each end for the leg to rest in. This, if provided with a band to go around the calves, holds the legs satisfactorily, and it only remains for the assistants to preserve them in their proper relative position. Another way of securing the patient is by fastening the ankles

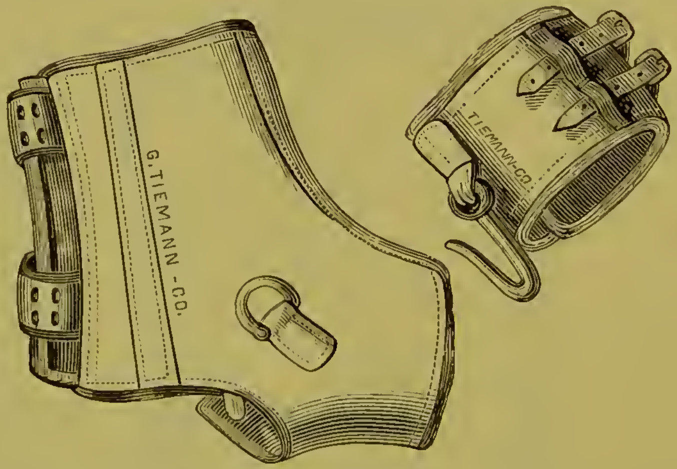

Fig. 71.—Anklets and wristlets.

and wrists together, which may be done by a soft piece of webbing, or by the anklets and wristlets manufactured for this purpose.

**The Operation.**—Ether having now been administered, the patient is placed upon the table, the bladder is emptied and washed out, and moderately distended with a boracic or other aseptic solution. The grooved staff is then entered and the stone is touched. This is an important precaution in this stage of the operation, for, besides the chance that the staff may be in a false passage and not in the bladder, there is also a possibility that no stone exists; and a review of the cases in which it has happened to thoroughly competent and skillful operators to find no stone after the bladder was opened, attests the importance of this precaution.

The patient is now brought into position at the foot of the table, and there secured. The staff, being properly in place, is intrusted to the assistant, and the same assistant may with his left hand hold up the scrotum during the operation.

Everything being now in readiness, the surgeon should examine the rectum to make sure that it is properly collapsed. The importance of keeping his hands absolutely clean may lead him to intrust this examination to an intelligent bystander, or to an assistant who can afterward give time to the disinfecting of his hands.

Being now seated in front of his patient, he informs himself of the position of the various landmarks mapping out the perinæum, reassures himself as to the position of the staff by making it prominent where it is easily felt in the perinæum, and then, carrying in his mind the plan of operation and the point at which he intends to strike his staff, he makes the incision.

This should commence a little to the left of the raphé, and from one and three quarters to one inch in front of the anus. The incision which begins farthest forward falls over the bulb of the urethra, and, in order to avoid wounding this, great care must be taken that the upper portion of the first incision be not carried too deep. The lower incision admits the operator more directly to the urethra at the point where he intends to open it, and less care is necessary to avoid wounding the bulb. As Thompson says, it is therefore a safer practice to err, if it be an error, by placing the incision too low rather than too high. Commencing at the point selected, it should run back over the ischio-rectal space for three inches. The superficial layers and the loose cellular tissues in the ischio-rectal fossa should be rapidly divided. The bulb of the urethra, if it comes into view, can be drawn somewhat upward, and the staff should be sought just below it. When the urethra is approached, the forefinger of the left hand should be introduced into the wound, and with it the groove in the staff be sought. When this is felt, the finger-nail should be pressed into it, and along this as a guide the knife should be entered until it can be felt scratching the metal of the staff.

Being sure, now, that the knife is firmly placed in the bottom of the groove, it may be carried into the bladder by one of two manœuvres. Either it may be slid along the groove and so through the prostate until it reaches the vesical cavity, or the operator may take the staff from his assistant, and, holding that firmly in his left hand, with the knife held fixedly in the groove so that there is no danger of slipping, he may then by a combined movement of both hands advance the staff and the knife into the bladder at the same time.

Having arrived at the vesical cavity, the prostate may be incised by simply depressing the handle of the knife, the point of the blade being still fixed in the groove of the staff. In making this cut the blade of the knife is not to be carried directly down in the line of the external incision, but should be directed more horizontally, so as to make the incision through the thickest part of the lateral lobe. In this way an incision of any desired extent may be made in the prostate, and the knife may then be withdrawn at once, care being taken not to cut with it during the withdrawal. In this way a more exact control can be had over the extent of the incision made in the prostate than when the cut is made during the withdrawal of the knife by sweeping the point outward. It is difficult in a deep wound to exactly calculate where the point of the knife is, and there is danger of making a more extended incision than is intended by the latter manœuvre.

The knife, being withdrawn, is laid down, and the right forefinger is introduced through the wound. If the incision in the prostate is found to be too small, the probe-pointed knife may be entered along the groove of the staff, and the incision enlarged by depressing the handle of the knife in the same manner as before. The finger is then introduced into the bladder, the stone felt, its size estimated, and the staff may then be withdrawn, the right forefinger being kept in the bladder. The staff then being laid down, the left forefinger may be introduced along the right, and with both fingers in the bladder, placed back to back, a separation of the finger-tips will produce a gradual and easily regulated stretching of the vesical neck to the extent desired. This having been accomplished, the right forefinger is withdrawn, the forceps are seized and passed into the bladder along the left forefinger, which is retained as a guide. The forceps, being carried well into the vesical cavity, are widely opened in a transverse direction, rotated in a quarter of a circle, and then closed. In this rotation one blade sweeps the floor of the bladder beneath the calculus, and when they are closed the stone will usually be found in their grasp. If difficulty is found in seizing the stone, owing to any peculiar location, forceps especially adapted to reach it may be selected, and under the guidance of the finger it may be seized and withdrawn. An irregularly shaped stone should always be so caught by the forceps that the smaller diameters shall pass through the opening. A stone having a length of three inches, if the other diameters do not measure more than one or one and a half inch, may be readily removed through the perinæum.

Traction in withdrawing the stone should be downward, the stone being worked through the soft tissues by a side-to-side motion of the forceps, while the soft parts are pushed back with the fingers of the other hand. Any real contraction of the soft parts is overcome by further incision with the knife, rather than by tearing with the forcible traction of the stone.

If the stone breaks in the forceps, it is to be removed piecemeal. This is sometimes rather difficult. The smaller fragments, which are not readily seized with the forceps, are best removed with the scoop, the finest sand and bits of stone being finally washed out by means of a syringe and tube passed to the bottom of the bladder, so that the current shall flow from within outward, carrying the *débris* before it.

An examination of the interior of the bladder should follow the removal of the stone, in order to make sure that there are no other calculi present, either loose in the bladder cavity or contained in pockets. The interior of the bladder may be brought down upon the examining finger by pressure above the pubes, in the method adopted in other bimanual pelvic examinations.

The stone being out, the stopping of any hæmorrhage which is going on is the next duty of the surgeon. All vessels in sight should be tied, and the deep portions of the wound should be explored if there is a persistent flow of blood from them. With well-arranged retractors this can usually be done quite satisfactorily. Occasionally a deep vessel may be found which it is difficult to put a ligature about. The tenaculum of Thompson may serve a good purpose here. It is hooked into the vessel and a ligature being tied beyond it, the tenaculum is left in place; or the pressure-forceps may be clamped on to the vessel, and left for a day or two projecting from the wound.

In case of a considerable oozing surface, as is sometimes left when the bulb of the urethra has been injured, it may be necessary to take a stitch in the bleeding portion and tie the tissue *en masse.* If this is done, great care should be taken not to encroach upon the caliber of the urethra. Usually the oozing from the bulb may be checked by packing the wound, and in this case a tube stiff enough to resist the pressure of the packing must be introduced into the cavity of the bladder for drainage. The best method of applying this packing is with the dilatable tampon of Buckston Browne, or with a chemise cannula.

The first of these is readily understood from the figure. The chemise cannula is prepared by binding a piece of cotton or linen cloth on to the tube between the encircling ridges near the eye. The point of the tube then being carried well within the bladder, the cuff of cloth that lies in the wound is lightly packed with strips of gauze, so as to make an even pressure in all directions. This packing may usually be removed in from twenty-four to forty-eight hours, and the cannula can then be easily withdrawn.

If the water used for washing out the bladder is hot, a good deal can be accomplished in the way of allaying the oozing by irrigation. When there is not sufficient bleeding to necessitate the use of a cannula, the wound is left to fall together, and may be protected by a loose pad of iodoform gauze laid over it, care being taken that this shall not be pressed in firmly enough to hinder the outflow of urine.

The patient may then be put to bed, and should be laid upon pads of oakum, wood-wool, or pine-fiber, sufficiently large to catch the urine as it flows. The greatest care should be exercised to protect the skin as far as possible from the effect of contact with the urine, by frequent washing with alcohol, and by smearing it with vaseline or some other oily substance.

At first the urine flows freely through the wound, but after a day or two the inflammatory swelling somewhat hinders its escape, and it may partially pass through the urethra. Later, as this swelling subsides and suppuration is established, the urine again may, for the most part, escape through the perinæum.

The patient should be watched somewhat closely for the first few days, as occasionally secondary hæmorrhage appears during that time.

Attempts at primary union of the wound have occasionally been successful, the approximation of the wound in these cases being accomplished by bringing the thighs snugly together and securing the legs, so that the wound shall not be stretched apart. These efforts have not succeeded often enough, nor is the time which is occasionally gained in this way of sufficient importance to warrant the additional risk of urinary infiltration. It sometimes happens that the outer part of the wound quickly heals or agglutinates, while the neck of the bladder, which has suffered the most injury during the extraction of the stone, does not so quickly unite. This condition is, of course, very favorable to urine infiltration.

The patient should be kept in bed usually from two to four weeks, although sometimes, in the case of children, recovery is much more rapid than this. The further treatment follows the same lines as that after lithotrity, with the addition of the care of the wound.

**Accidents and Complications during Operation.—Hæmorrhage.**—An unusual position of the perineal arteries may give rise to a profuse hæmorrhage at the first incision. This should be at once stopped by ligature, as much blood may be lost if it is postponed until the end of the operation.

Hæmorrhage from the deep incision may usually be left until after the removal of the stone, as the pressure of the fingers and the instruments with which extraction is being made prevents any very great loss of blood in the narrower or deeper parts of the wound. The methods of controlling it after the operation have been considered.

**Failure to enter the Bladder.**—If false passages exist in the urethra, the sound may, during the operation, slip back out of the bladder and enter one of these. This, of course, is prevented by a skillful assistant, if he directs his attention to preserving the sound in the proper place, but in careless hands it is not impossible. When it occurs, it may be the source of serious trouble. If the sound is advanced into the bladder at the same time that the knife enters, the surgeon will usually recognize that it is caught in a false passage, and can then rectify its position. If, however, the knife is slipped along the groove of the staff while that is held stationary, its faulty position may be discovered only after an extensive wound has been made. To correct this unfortunate state of affairs, the staff should be partly withdrawn and carefully guided into the bladder, where it will again touch the stone, and the proper incision can then be made upon it.

It occasionally happens that, even after the urethra has been incised, the opening into it is so small that the finger can not readily enter it. In a child the too violent effort to push the finger on into the bladder has occasionally forced the bladder so far backward as to separate it from the membranous urethra. This is so serious an accident, that the greatest care should be taken to avoid it.

To the skilled operator the sensation imparted to the finger as it enters the urethra and passes through the neck of the bladder is so characteristic that it can not be mistaken. If difficulty is encountered, it is better to introduce a director along the line of the staff, and, upon this as a guide, to enlarge the incision. If the attempt is made to enlarge the incision simply by again using the sharp-pointed knife in the groove of the staff, there is danger of entering the staff through another opening, and thus making two incisions into the urethra.

**Injury to the Bladder.**—This may be caused by a sharply pointed staff, and Thompson has recommended that the staff be curved on a rather short axis, to avoid this accident. It is unlikely to occur if the bladder is moderately distended with water, but is to be looked for in case of a contracted bladder. Also, in a small bladder care should be taken that the point of the knife does not come in contact with the posterior wall; and the same precaution should be observed after the urine has escaped and the bladder has shut down. When the prostate is of sufficient size to admit of the removal of the stone through an incision made into it alone, care should be taken not to carry the cut into the body of the bladder; but practically the cases in which this occurs usually do well, if there is not much laceration of the parts. In cases of encysted stone, the bladder wall may be torn in efforts to dislodge the stone. If it is discovered that the bladder wall has been injured, especial care should be taken to provide for drainage, so as to prevent any infiltration of urine.

**Wounding the Rectum.**—The importance of great care to avoid this mishap is shown by the fact that it has so often happened to the most skillful operators. It is especially liable to happen to old men with lax, dilated rectum, especially if dilated with flatus. The precautions which should be taken to avoid this are: First, to see that the staff is not pushed downward toward the rectum while the incision is being made; second, to make the deep incision laterally, not downward; lastly, in a difficult case, the rectum should be held down with the fingers of the other hand while the lateral incision is being made. If the point of the knife is swept along the lower angle of the incision as it is withdrawn, this accident is more likely to happen than when incision is made in the way recommended in the description of the operation, by depressing the handle of the knife and not cutting during withdrawal.

It is usually recommended that the wounded rectum be left to itself, and in many of the cases thus treated healing finally occurs. In case, however, the opening can be distinctly brought into view, there seems to be no objection to the application of stitches bringing the rectal wall together, but not including the mucous membrane. In any event, care should be taken to keep the wound clean by thorough irrigation, and to regulate the bowels by laxatives and enemata.

When healing does not occur, it is likely to leave a urethro-rectal fistula. Systematic catheterization, by absolutely preventing the contact of the urine with the fistulous tract, will sometimes allow this opening to close. When it does not, if the fistula is within reach from the outside, attempts may be made to close it by plastic operation, and the mucous membrane of the rectum may be slipped down over it and stitched. In this case, too, the urine should be diverted from contact with the wound during the healing process.

**Excessive Depth of Perinæum.**—This may be a serious complication, and make the execution of the operation very difficult. If the finger can not reach the bladder, the forceps may be guided into it along the groove of a blunt gorget, as advised by Thompson, or along the ridge of a crested scoop, which is the method advised by Keyes. The forceps for such a case should have exceptionally long handles, and the shafts of the handles should shut by each other, so as to allow them to be opened widely in the bladder, even while the handle is in a confined space. The difficulty of the operation through such a perinæum is so great, that, if the condition is previously recognized, it would usually be proper to choose some other method of operating on that account.

**An Enlarged Prostate** may similarly so lengthen the route to the bladder that the finger can not reach it. Similar devices should be used in this case; and as, in cases of enlarged prostate, the *bas fond* is likely to be deep, a curved pair of forceps are usually necessary in order to reach the stone. Sometimes, in case of an enlarged prostate where the third lobe is prominent, it will be caught in the forceps when closed, and may make the use of the forceps difficult. If it is easily accessible, it may often be proper to remove it; and cases are reported in which this procedure has been followed by the return of normal urination, after such had been absent for some time.

Occasionally tumors will be felt in the prostate, which may be shelled out. In each case the operator must judge from the circumstances whether this is advisable. It has been done many times with good results. Gross reports one case in which a suppurating pocket was left by such a procedure. The present position of surgeons in the treatment of enlarged prostate favors this operation.

**A Tumor of the Bladder,** if met, may be operated upon with forceps and curette, provided it can be made accessible. If not, it may be wise to change the plan of operation, and add the suprapubic incision to that through the perinæum.

**Unnatural Rigidity of the Neck of the Bladder** is mentioned by Thompson as occurring in old men. Allied to enlargement of the prostate, it adds to the difficulty of getting sufficient room for the extraction of the stone. The tissues yield but little to efforts at dilatation, and free incisions must be made on both sides of the prostate before the requisite space can be obtained. Fortunately, the tissues, when in this condition, will bear more violence than when in a normal state.

**Encysted Stone.**—A stone may be encysted by irregular contractions of the bladder, in which a part of it shuts down about the calculus and holds it entrapped in an offshoot from the main cavity, or the stone may form in a diverticulum which existed previously. If the stone is not readily felt when the finger enters the bladder, careful search should be made over the whole cavity of the viscus.

As the finger can not readily reach all parts of the wall, this examination should be made with the vigorous help of the other hand pressing in over the pubes and forcing the various parts of the bladder wall down on to the examining finger.

If the encysting of the stone is only caused by muscular contraction, the neck of the sac which is formed can usually be dilated, and the stone then falls into the general cavity, from which it can be readily removed. If it is not easily dislodged, it may be seized with a pair of suitable curved forceps and withdrawn.

When the stone forms in a diverticulum, it may project into the cavity of the bladder, or it may be wholly contained in the side pocket. If such a condition is suspected before operation, the suprapubic incision would usually be selected rather than the perineal. Occasionally, when the perineal incision has been made for exploration, an encysted stone may be found, and the possibility of removing it by that route will then depend on the position of the stone and the ease with which it can be reached, and also on the relative size of the neck of the sac and that part of the stone contained within it. Unless the neck of the sac is large in relation to the stone, it is best to make at once the suprapubic opening; and the same is the best procedure when the pocket is so far from the perinæum that it can not be easily reached.

When the conditions are favorable for perineal removal, it will usually be found that a small spoon, under the guidance of the finger, is the best means of dislodging it. If the forceps are used, care should be taken not to seize a portion of the bladder wall with the stone, and also not to lacerate the neck of the sac by too forcibly dragging the stone through it. If the bladder wall is injured, an unfortunate result may usually be averted by providing thorough drainage until the rent is healed. If the stone is adherent to the bladder wall, it may be scraped out with a scoop and removed. In that case, it is well to thoroughly curette the surface to which it is attached, in order to remove any bits of calcareous matter with the granulations upon which they were deposited. In such a case it is important to afterward guard against the alkaline fermentation of the urine. Keyes advises the after-use of irrigation of the bladder with dilute nitric-acid solution.

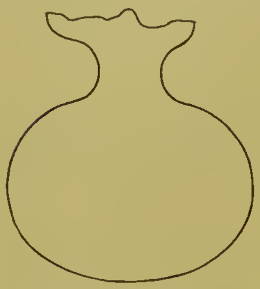

Fig. 72.—Outline sketch of encysted stone, in which only the small rough surface above projected into the bladder.

**Stone too large for Perineal Removal.**—If the stone is so large that it can not be safely removed through the perinæum, it may either be broken by instruments introduced through the wound, and so removed piecemeal, or it may be removed by suprapubic incision. The method of fragmentation will be considered under perineal lithotrity.

## COMPLICATIONS WHICH MAY ARISE SUBSEQUENTLY.

**Hæmorrhage.**—As has been said, the patient should be watched for secondary hæmorrhage. If this appears, it may usually be stopped by the use of the cannula with an air-tampon, or by the chemise cannula, with the packing of the wound. I have seen one case in which a young man had several attacks of hæmorrhage which packing failed to stop, and which compelled a reopening of the wound and ligature of an artery believed to be that of the bulb.

If the bladder fills up with blood-clot, it is an uncomfortable complication, and may prove serious. Irrigation should be tried, and hot solutions of pepsin, or other digestant, have been used to dissolve the clot. Opiates should be given to allay the spasm, and usually the escape of urine is sufficiently free to allow of waiting till the clot breaks up. If, however, the urine does not find its way out, and there seems to be danger of suppression, the clot may be broken up and evacuated. This may be accomplished with the litholapaxy-pump and a large tube introduced through the perineal wound. The bleeding usually comes from the deep wound, and this, therefore, should be again carefully packed after the blood is removed.

Usually hot water is a sufficiently good astringent, but, if more constricting action is required, alum may be added to it. If there is a tendency to a continuation of the hæmorrhage from the mucous membrane, ergot may be administered internally, to assist the contraction of the bladder wall and prostate, as well as of the small vessels.

**Retention of Urine,** if it occurs, should be relieved by the temporary introduction of a tube, and it should be remembered that provision for the free escape of urine is one safeguard against the occurrence of suppression. The treatment of this, if it occurs, should follow the lines laid down in the consideration of its possible appearance after lithotrity.

**Calculi or Fragments left in the Bladder.**—This accident is to be feared in cases of multiple calculi, especially in a sacculated bladder. If the first stone or stones removed are faceted, others are to be looked for. When a stone breaks in the grasp of the forceps, the fragments are often very hard to find and thoroughly remove, even with the intelligent use of the scoop and irrigation.

If a fragment or other calculus is left, its presence may be suspected if the irritation in the bladder does not subside. It may best be sought by the introduction of a litholapaxy-tube, and, if it is small, it may be quickly removed by the evacuator. If somewhat larger, it may be crushed and pumped out, or it may be seized and drawn out with forceps.

**Phosphatic Incrustation of the Wound.**—This occurs occasionally, appearing from the seventh to the fourteenth day. Thompson, who has met with this condition a number of times, advises hip-baths and irrigation with acidulated water. He says that sometimes the accumulation of phosphatic material is considerable in the deeper parts of the wound, and may require the use of the forceps for its removal. On one occasion he was obliged to crush a little calculus that formed at the bladder end of the wound. The curette may do good service in removing the calcareous matter and the granulations on which it is deposited.

### WOUND COMPLICATIONS.

The lithotomy wound is naturally liable to various wound diseases, the more so as absolute asepsis is practically impossible. Erysipelas, diphtheria, pyæmia, and septicæmia are to be occasionally expected, and when occurring should be treated on general surgical principles. Inflammation arising in the wound may also extend to the parts about, and give rise to cellulitis, phlebitis, prostatitis, or cystitis. Occasionally even peritonitis may arise after perineal lithotomy, being caused either by perforation or injury of the bladder wall, or by wounding the posterior fold of the peritonæum, which sometimes comes low down over the prostate, and may be reached if the incision is extensive. More remotely, the inflammation may reach the kidneys, or the epididymis and testis. Extension in this last direction may be especially looked for if the seminal ducts or vesicles are injured.

Besides these more serious complications, the wound may heal slowly, the granulations may be sluggish or exuberant, and there may be a tendency to the formation of a fistula. When this is the case, the track may be cauterized with a hot iron, or with nitrate of silver. The importance of diverting the urine from such a sinus has already been alluded to in reference to the treatment of recto-urethral fistulæ.

It should also be borne in mind that the tendency to the formation of a perineal fistula is greatly increased by any narrowing of the anterior urethra which obstructs the flow of urine through it. Such a stricture, if it exists, should be dilated by the passage of sounds, or in such other way as seems best.

**Injury to the Seminal Ducts or Vesicles.**—Cases of impotence from this cause have been alluded to in the consideration of the choice of operation. This possibility should be borne in mind in guiding the incision through the prostate, which should be directed outward rather than downward. The loss of sexual power after the operation may appear either as impotence, or, what is more common, as sterility. Numerous instances of the latter are on record. In many of these the evidence is not good that the trouble is due to injury of the ducts; for when, as has happened in many of them, the fault is in the power of ejaculation at the time of intercourse, the seminal fluid dribbling away after the act is over, it seems probable that this failure in the act is partly, at least, due to injury of the ejaculatory apparatus, or of the erectile tissue in the prostate that directs the flow of semen.

There is little or nothing to be done in the way of treatment, although it would be fair to try the use of sounds and of mild currents of electricity, in order to restore the tone of the muscular apparatus of the deep urethra.

**Incontinence of Urine** is fortunately of rare occurrence. Although both the sphincters of the bladder are divided in the operation, the healing is generally sufficiently complete to restore their function. When this is not the case the incontinence may depend partly upon general debility, and should be treated with tonics, among which strychnia should hold a place. The use of ergot, too, may strengthen the contraction of the voluntary fibers in the prostate. In addition to these, electricity may be of use. These measures failing, the patient should wear a urinal.

**Stricture of the Urethra.**—It has been claimed that this never results from the incision for stone, and it is probably true that a snug stricture is never so caused.

Since, however, Otis has called attention to strictures of larger caliber, and has shown that they may occasionally give rise to discomfort and inconvenience, there is need that this subject be again reviewed. It seems not improbable that slight narrowing of the membranous urethra would occasionally be found were old stone patients carefully examined with reference to this point. I have met with one case in which a man who had been cut many years before suffered from an intractable cystitis, and a slight narrowing of the membranous urethra was found.

The use of large sounds in this case showed that it was not a spasmodic stricture, but a dense, organic narrowing which could only be dilated by the use of considerable force, and which could never be brought quite up to the caliber of the rest of the canal.

## BILATERAL OPERATION.

After the same preparation of the patient as for the median operation, the incision is made in a crescentic way across the perinæum, crossing the raphé at a point about an inch in front of the anus. It is carried down until the bulb is exposed; this is drawn upward, and the urethra is opened in the membranous portion. The staff, which has a central groove, is here exposed, and along it Dupuytren's double concealed bistoury is slipped into the bladder. The staff is now withdrawn, and the blades of the bistoury being pressed out sideways to a distance previously

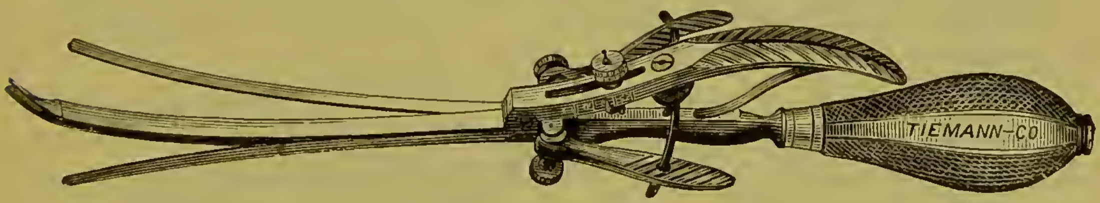

Fig. 73.—Dupuytren's double lithotome caché.

arranged for with a set screw, this instrument is withdrawn, cutting into the lateral lobes of the prostate. This withdrawal should be in a line somewhat directed downward, in order to have the blades traverse the thickest part of the gland. The finger is then introduced, and the stone is extracted just as in the lateral operation.

## MEDIAN OPERATION.

In this operation a staff in the urethra with a wide groove on its under surface is used (Fig. 54). This may be reached either by an incision from the outside on the median line, rapidly dividing the tissues down to the urethra, or by a direct thrust the knife may be carried into the groove of the staff and the incision then made from the urethra outward, while withdrawing the blade.

If the latter method is intended, the left forefinger is introduced into the rectum with its palmar surface upward. With it the apex of the prostate is sought and the staff is felt entering it. A narrow, straight bistoury, with the cutting edge directed upward, is now entered in the middle line about half an inch in front of the anus, and carried by direct thrust into the groove of the staff. The bistoury employed has a short cutting edge on the back, and as it is pushed along the staff this cuts into the apex of the prostate. Now, while withdrawing the knife, the cut is made upward along the raphé. A straight grooved director is now introduced into the bladder, the staff is withdrawn, and along the director the finger is introduced.

If the fingers are not sufficient to produce enough dilatation to allow of the removal of the stone, more room may be gained by making incisions either directly downward into the prostate, which is the direction in which the median incision is made, or by lateral incision added to this, if more room is desired. Various methods have been employed to distend and enlarge the space obtained by the median incision. Forcible dilatation with special instruments has been practiced to some extent, but has little or no advantage over the use of the fingers, with the addition, if necessary, of a probe-pointed bistoury.

In the *medio-bilateral operation* the incision is to be made from without inward, until the membranous urethra is opened, and then through the groove of the staff the double lithotome caché of Dupuytren is to be introduced and the incision made through the lateral lobes of the prostate, exactly as in the bilateral operation.

Other methods of performing perineal lithotomy might be mentioned, such as the prerectal, the operation upon an angular staff of Buchanan, the operation upon the straight staff of Aston Key. These operations are, however, at the present time, practically out of date, and descriptions of them would be out of place in this account of modern procedures.

They can be found fully described in Keyes's exhaustive article on Stone in the Bladder, published in Ashhurst's Encyclopædia of Surgery, and also in Thompson's Practical Lithotomy and Lithotrity.

### 4. Perineal Lithotrity.

In the performance of lithotomy it has always been a frequent occurrence to have the stone break or crumble in the forceps. The idea has therefore forced itself upon many operators, that by fragmentation much larger stones could be removed through the perinæum than would otherwise pass this route.

Many instruments have been devised to accomplish this end, some of which are here represented. While this method has been used by many surgeons to supplement the ordinary operations for stone removal, and to help them out of a hard place when they were brought face to face with a large stone and insufficient room for its removal, the suggestion that perineal lithotrity should be made a regular procedure to be often resorted to in preference to other methods, has been made by a few operators.

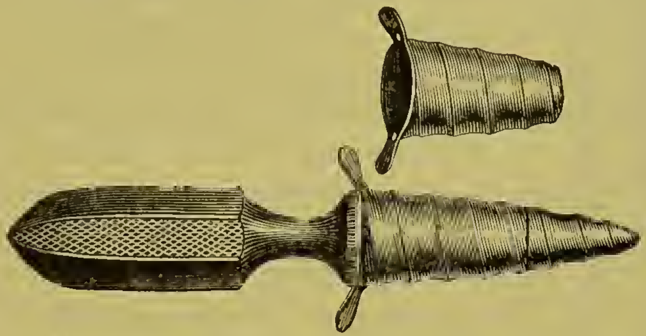

Fig. 75.—Dolbeau's shield to protect the walls of the wound during crushing.

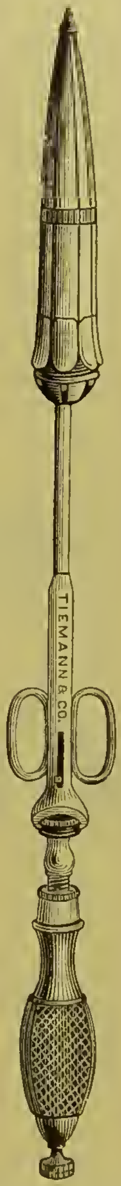

Fig. 74.—Dolbeau's dilator.

Dolbeau devoted much thought and ingenuity to the elaboration of this operation, and, with his ingenious dilator introduced through the median incision, he proposed to dilate the neck of the bladder to a size sufficient for the introduction and operation of his powerful lithoclast. His endeavors, however, were never successful in establishing this operation on a firm basis.

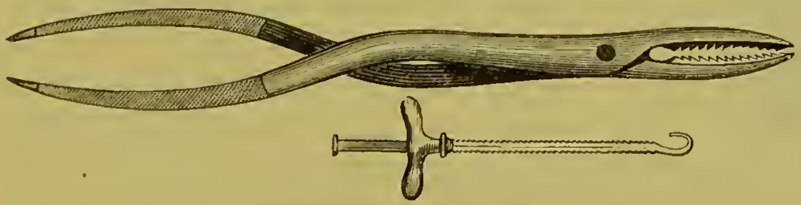

Fig. 76.—Dolbeau's lithoclast.

At the time when the treatment of stone was in its transitional state, in the seventh decade of this century, Harrison again brought forward the question of crushing stones through the perinæum, and urged its wide adoption. Soon after, however, the appearance of litholapaxy, and the papers of Garson and Peterson on suprapubic technique, turned the attention of surgeons in other directions.

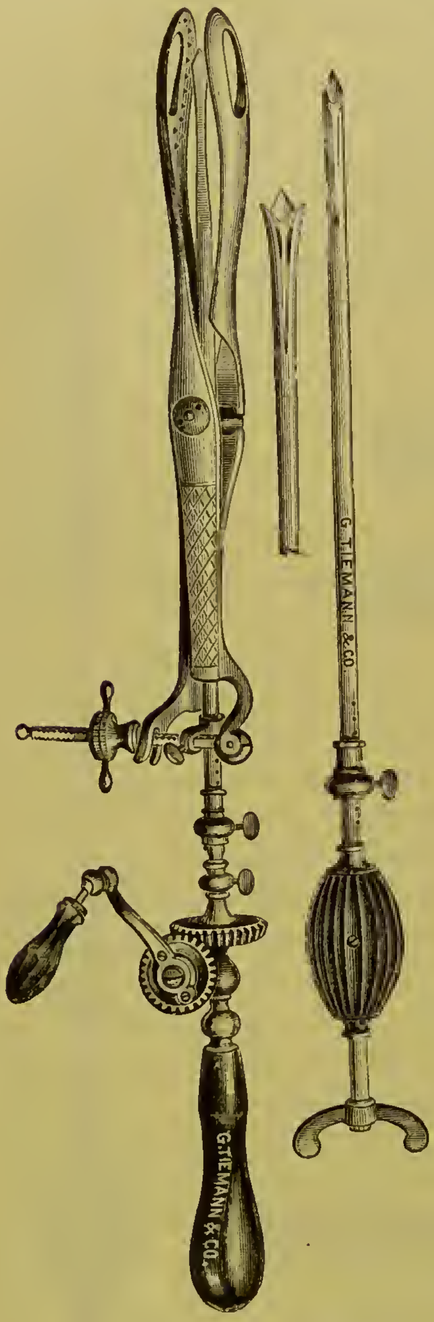

Fig. 77.—Rigal's stone perforator and crusher.

Now, again, a strong advocate for this operation has appeared in the person of Surgeon-Major J. R. Keith. His experience in stone operations has been gathered in India, where he has had a considerable experience. Allusion has already been made to his method of evacuation after crushing. Having met with several cases in which the stones were too large to be grasped by the ordinary lithotrites, owing to the separation being so great that the screw would no longer lock, he had a larger lithotrite constructed with a longer screw, with the purpose of using it through a perineal opening.

He has operated upon several cases in this way, simply by incising the membranous urethra, and conducting the whole operation through the thus shortened route. Occasionally he has met a stone so large that it can not be grasped even by this large lithotrite. In such cases he somewhat enlarges the incision in the perinæum, and dilates the membranous and prostatic urethra to a size through which he can easily introduce a pair of strong lithotomy-forceps. With these he seizes the stone, and while holding it firmly he introduces a chisel, fixes its edge against the stone, and then, with the blows of a hammer, breaks it. At the same time he forcibly closes the forceps, and thus brings out any fragments that remain between the jaws. This proceeding he repeats until he has brought the whole stone away. He says that in this way he on one occasion removed a stone weighing seventeen ounces. His reported results have certainly been very good, but his methods have not yet been tested by other operators. Whether they constitute an advance in the treatment of stone, time will show.

### 5. Suprapubic Lithotomy.

Turning now from perineal operations, we find that the only other portion of the bladder wall uncovered by the peritonæum through which an incision can be made lies in front of the prostate, and rises a short distance above the pubes in front. Many anatomical operations have been devised for entering this portion of the bladder. Attempts have been made to push the penis downward, and enter beneath the pubic arch. Other plans have contemplated a division of the pubes. These theoretical routes have had so little to recommend them that they have never been put to practical use.

The suprapubic incision, however, which enters the bladder just above the pubic arch, has lately become an operation of the greatest importance in the consideration of surgeons.

The recent advances in technique and in wound-treatment have, within the past decade, lifted this operation out of comparative obscurity into the position of being one of the surest and most satisfactory of surgical methods. This subject has been also treated in the article upon the removal of bladder tumors. To avoid repetition, therefore, as far as possible, the account which follows will leave out much of the history and many considerations which arise in connection with this operation, and will only emphasize those points which are particularly to be remembered in connection with the treatment of stone.

**History and Development.**—The first recorded instance of suprapubic lithotomy is that of Pierre Franco. In 1561 he cut a boy two years old for stone, and finding the calculus too large to remove through the perinæum, and urged by the importunities of the parents and the necessities of the case, he pressed the stone upward with the fingers in the rectum, and cut down upon it over the pubes. The child, though very sick, ultimately recovered. Franco was so impressed with the serious nature of this operation, and with the then common belief that wounds of the body of the bladder were almost necessarily fatal, that he strongly advised against a repetition of the procedure which had proved so successful in his hands.

In the year 1580 François Rousset perceived the importance of distention of the bladder to increase the space between the peritoneal fold and the pubes, and advised that the bladder be filled with barley-water, milk, or some mucilaginous fluid, the escape of which should be prevented by compression of the penis. When the bladder was small and contracted, he counseled efforts at gradual distention by diuretic drinks, coupled with efforts at forced retention of urine. He recommended that the operation should be done with the patient on his back and the pelvis raised, so that the force of gravity should draw away the intestines, and that the liquid in the bladder should gravitate to the fundus and draw it out of the pelvis. He advised that the incision should be in the median line between the recti and pyramidales muscles, and that while the peritoneal fold was retracted and protected by the forefinger a small opening should be made in the bladder, and afterward enlarged at need with a probe-pointed bistoury. We have in these recommendations of Rousset an outline of the best modern treatment. He saw and urged the advantage of the Trendelenburg position, with distention of the bladder, and his method of reaching the bladder is the one now employed. The completeness of his understanding of the situation is the more remarkable when it is known that he was not a surgeon, and never performed the operation that he so ably planned.

Suprapubic lithotomy did not obtain a firm foothold in surgical practice until the eighteenth century, when it was revived by Douglas (1719), Cheselden (1723), and Morand, but then only as an exceptional method.

Toward the end of the century Frère Come (Baseilhac) introduced the sonde-à-dard, with the aid of which he did many successful operations. His method of using this instrument was as follows:

When the median incision close above the pubes had been carried down to the bladder wall, the sound, with its concealed dart, was introduced into the bladder. The operator then put the forefinger and thumb of his left hand to the bottom of the wound, and with his right hand carried the beak of the sound with a seesaw movement along the anterior bladder wall, until its point came under the middle of the wound. The handle of the sound was now depressed, and the point raised a nipple-like projection of the bladder wall, which was seized with the left finger and thumb. During this part of the operation the peritonæum was carefully pushed toward the umbilicus.

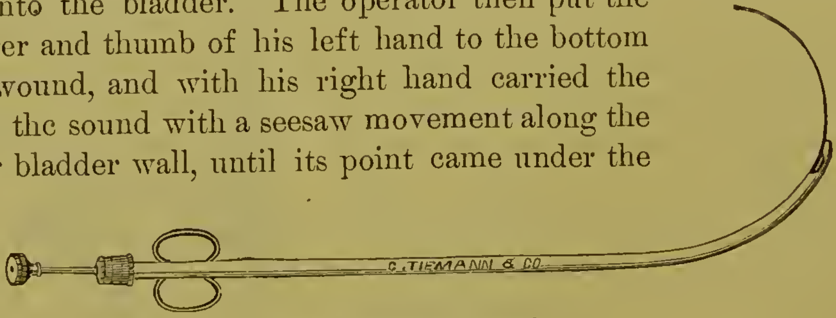

Fig. 78.—Sonde-à-dard.

The sharp-pointed director was now pushed out of the sound, appeared through the bladder wall, and served as a guide to a bistoury, which made a small opening, through which the index-finger was at once slipped to hook and hold up the bladder, and to serve as a guide for further incision and for the manipulations of removing the stone.

Frère Come also practiced and recommended a perineal opening for purposes of drainage in patients cut over the pubes.

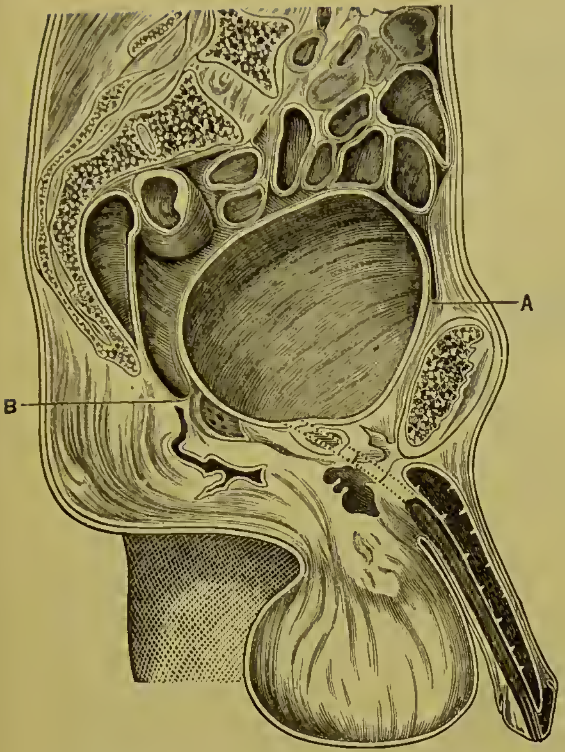

FIG. 79.—Cut from frozen section. Bladder contains ten fluidounces. A, prevesical fold of peritonæum; B, retrovescial peritoneal fold.

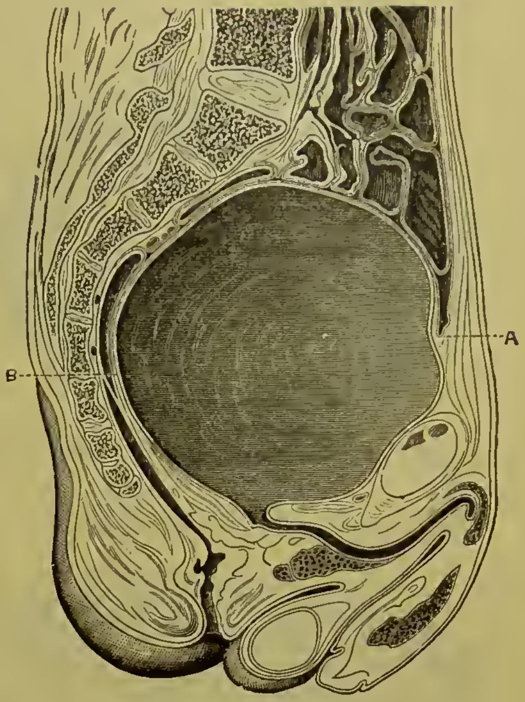

FIG. 80.—Bladder distended with twenty fluidounces. A and B, folds of peritonæum.

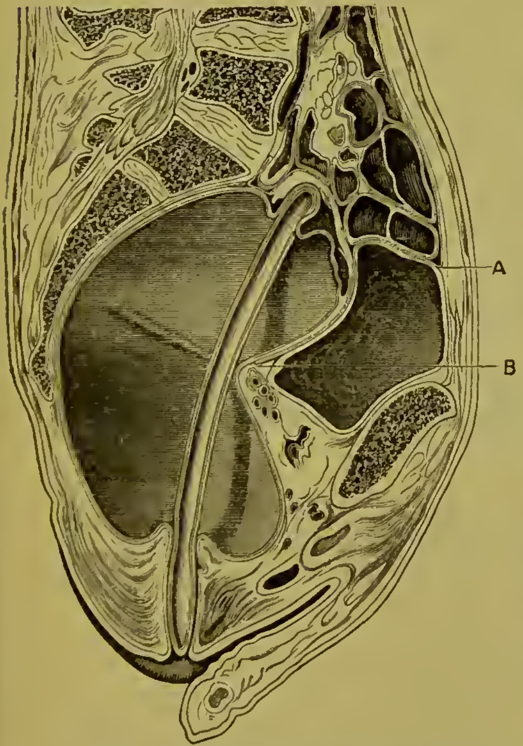

FIG. 81.—Bladder contains six and a half fluidounces. Rectum distended with fifteen fluidounces. A and B mark the peritoneal folds.

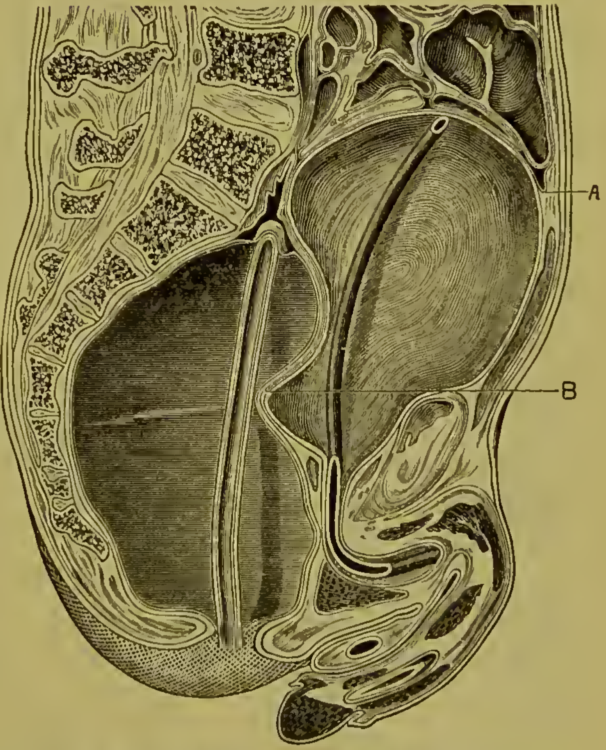

FIG. 82.—Bladder contains fourteen fluidounces. Rectum distended with sixteen fluidounces. A and B, folds of peritonæum.

For more than a century after this the operation remained practically at a standstill in the matter of technique; and in the estimation of surgeons it steadily declined in importance on account of its high mortality, and of the improved methods of treating large stones through the perineal opening with powerful crushing instruments.

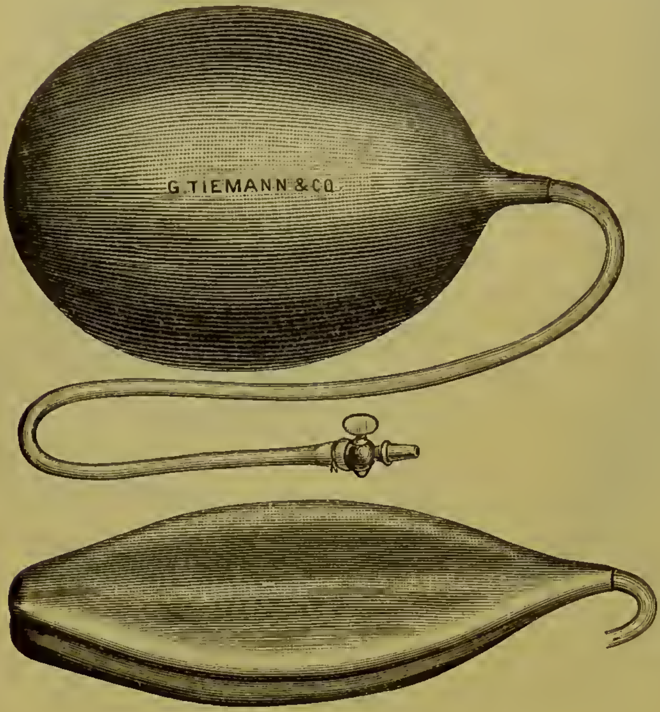
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Fig. 83.—Rubber bag for distention of the rectum.

In the Dictionnaire de Médecine, published in Paris in 1844, is a fair summary of the feeling of the time. The advantages of the operation in the avoidance of hæmorrhage and of interference with the urethra and prostate are dwelt upon, as well as the fact that it is the only possible operation in cases of very large stones. On the other hand, the author draws a gloomy picture of the course and fatal effects of urinary infiltration, and closes by saying, "It is, then, owing to the danger of urinary infiltration, after this operation, that the great majority of surgeons have preferred, and still prefer, the narrow and embarrassed route that the perinæum presents to ordinary calculi."

This opinion of the operation, expressed in 1844, was not materially altered during the subsequent thirty years. The technique usually followed during this period was essentially that of Frère Come with the sonde-à-dard, although occasionally the operation was done after the manner recommended by Rousset over a full bladder.

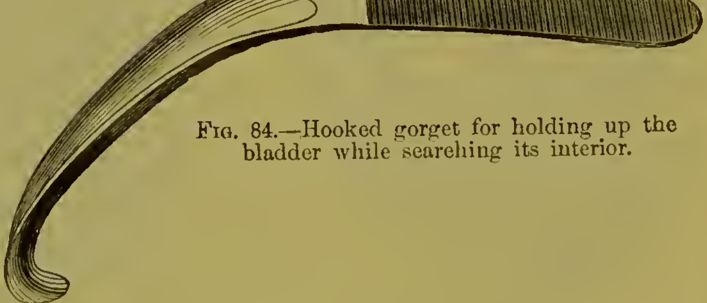

Fig. 84.—Hooked gorget for holding up the bladder while searching its interior.

In October, 1878, Garson, of Edinburgh, published some investigations made in the laboratory of Braune, of Leipsic, upon the changes of position of the pelvic organs when the rectum was distended by an inflated rubber bag. The surgical importance of his observations was at once manifest, for he found that the bladder was lifted out of the pelvis to a considerable degree, and that the prevesical peritoneal fold was widely separated from the symphysis pubis, thus giving room for the performance of the suprapubic incision without fear of injury to the peritonæum. At about the same time Braune brought this matter to the attention of German surgeons, and in 1880 Petersen appeared with an article in Langenbeck's Archiv für klinische Chirurgie, recommending the procedure as a good one surgically, reporting two cases operated on in this way, and recounting a number of personal observations made on the cadaver.

This paper of Petersen's gave a great impetus to the operation, which since that time has continued to make its value more and more felt.

**Anatomy of the Prevesical Space.**—The peritonæum, as it is reflected from the anterior abdominal wall on to the top of the bladder, does not descend as low as the upper edge of the pubes. The loose, cellular space between this fold of the peritonæum, extending down between the abdominal wall and the posterior surface of the pubes in front, and the bladder wall behind, is known as the prevesical space, or the space of Retzius (cavum Retzii). The distance between the peritoneal fold and the upper edge of the pubes varies considerably in different individuals and at different ages. It is relatively greater in children, for in them the pelvis is small, and the bladder lies for the most part in the abdomen. This interval, too, varies greatly with different degrees of distention of the bladder; and in the Garson-Petersen method, the bladder being forced up and forward by the dilatation of a balloon in the rectum, the peritoneo-pubic interval is still further increased.

In some cases there is a distinct layer of fascia, connecting the peritonæum with the pubes (transversalis fascia, fascia propria of Velpeau), and if this is well developed it may do much to frustrate attempts to artificially increase the distance between the two.

**Preparatory Treatment.**—If the bladder is much contracted, efforts may be made with warm injections to stretch it to a reasonable capacity; and if there is cystitis present with fermenting urine and mucus, an emollient and mildly antiseptic solution of borax or boracic acid may be used for this irrigation. On the day of the operation the bowels are to be thoroughly emptied by laxatives and enemata.

**Description of the Operation.**—The patient being fully etherized on a table of convenient height, an oval or pear-shaped rubber bag is introduced into the rectum. This is easily done before the bladder is filled. Before distending the rectal bag the bladder should be thoroughly irrigated and then filled with a borax solution.

The filling of the bladder should be done with extreme care, as rupture of the viscus has occurred in several instances during this procedure. If a bulb syringe is used, the hand recognizes the amount of resistance, and can judge with considerable accuracy of the tension of the bladder. It is to be borne in mind that these bladders have usually been long diseased, and are not infrequently weakened by ulceration or sacculation. In most cases from six to ten ounces may be safely thrown in. To prevent subsequent leakage of water from the bladder an elastic band may be tied round the penis, but this had better be dispensed with if the bladder shows any tendency to spasmodic action. The rectal bag is now to be slowly filled with water, and here, too, great care should be taken against over-distention, for there is danger not only of rupture of the rectum, but also of so increasing the tension of the bladder as to cause a rupture there. During the filling of the rectal balloon the rise of the bladder into the abdomen may be watched by palpation and percussion.

Some operators prefer to dispense with this rectal distention altogether, and operate either without special effort to increase the distance between the pubes and the peritonæum, or endeavor to accomplish this object by putting the patient in the Trendelenburg position, with the hips raised, so as to cause the abdominal contents to fall away from the pelvis, and to allow the bladder, drawing in the same direction by its weight, to separate the peritoneal fold from the pubes.

The incision is now made in the median line, extending two and a half to four inches upward from over the symphysis pubis. The length of the opening will be varied according to the thickness of the abdominal wall. The incision is carried down between the recti and pyramidales muscles into the prevesical space (cavum Retzii). In many cases the bladder wall is now at once in plain view, but in others a layer of cellular tissue, containing more or less fat, has to be separated. This should be done by dividing it directly down toward the bladder, and any dissection or separation of these loose tissues laterally should be carefully avoided, as such handling of them opens up the way for infiltration of urine and septic absorption.

Sometimes veins of considerable size lie at the bottom of the prevesical space, and these, when seen, may be clamped and cut, or, if possible, pushed to one side. If they are injured and give rise to troublesome hæmorrhage, it should be borne in mind that this bleeding usually stops when the bladder wall is incised, much as the venous hæmorrhage in the neck, in the operation of tracheotomy, ceases when the trachea is opened; so that, if the bleeding points are not easily seen and caught up, the search should not be prolonged, but the bladder should be at once opened.

If the peritoneal fold is held down in close proximity to the pubes by the prolongation of delicate fascia which attaches it to the bone, it can be easily separated with the scalpel and drawn upward.

The bladder, when uncovered, should be opened by a clean thrust of the knife. The left forefinger, which is during this part of the operation protecting, and, when necessary, holding up the prevesical fold of the peritonæum, should be at once slipped into the opening while it is distended with the escaping urine. The incision can then be enlarged according to need, either by stretching, or with a probe-pointed bistoury. The opening should be sufficiently large to allow the passage of the calculus without undue bruising of the edges of the incision. The finger that is in the bladder serves as a guide for the forceps, and also appreciates any tightness of the wound which needs to be relieved by incision.

The stone being removed, careful search should be made to see that there are no bits of calculous matter left, and to detect, if possible, the existence of sacculi, in which stone formation may have taken place. Any further operative measures, such as the removal of a tumor or a prominent prostatic lobe, may now be undertaken.

If the stone is contained in a diverticulum, care should be exercised not to unnecessarily lacerate the bladder wall in its removal. The opening should be dilated as far as possible by gentle force, and if the stone can not be removed through it, it is perhaps better to crush it *in situ* and remove it piecemeal, than to run the risk of urinary infiltration, which would attend any incision into the bladder wall. Such incisions have, however, been used with success, and Bryson speaks of laying open these pockets in the hope of obliterating them. This was not accomplished in his case, though the patient did well. When diverticuli are present, it is to be borne in mind that these are sometimes symmetrically arranged, a knowledge of which fact may lead to the detection of stones in pouches so small that they would otherwise be overlooked.

**The After-Treatment of the Suprapubic Wound.**—The first important question we have to decide in the matter of the after-treatment is, whether to apply sutures to the bladder wound or not. There is considerable difference of feeling among operators as to the wisdom of doing so. Statistics are too meager to prove either plan decidedly superior, but, as far as they go, they show that patients have done better when the bladder wound was not closed, but was used for drainage. The added danger in the cases where the wound has been closed seems to come from the increased chance of infiltration of urine and septic infection, when the bladder leaks after the outer part of the wound has partly united.

The failure to unite has no doubt been due, in many instances, to the fact that improper cases were chosen for closure. It is evident that when the bladder wall is much inflamed, especially in old and broken-down subjects, the chances of healing by first intention are very small, and the dangers of urinary infiltration are proportionately large. Only those cases, then, should be selected for suture in which the bladder is tolerably free from inflammation.

Further, if there is much hæmorrhage into the bladder which can not be checked at the end of the operation, this is to be looked upon as a contra-indication to the closure of the bladder wound by sutures. For it is difficult in such cases to conduct off the urine, owing to the stoppage of the tubes with clots; and when these are clogged, the efforts of the bladder to free itself soon reopen the wound.

In spite of these drawbacks in the use of sutures of the bladder, the quick recoveries that are obtained in those cases in which the suture does hold are so striking that operators are constantly endeavoring, by improvement in technique, to make first intention of the suprapubic wound a comparatively sure thing, and many are so sanguine as to believe that this effort will finally be successful, and will place the suprapubic operation easily at the head of the procedures for the treatment of the interior of the bladder. Many forms of the continued and interrupted suture have been used in these wounds, but perhaps the most useful has been the interrupted Lembert suture, which is easily applied, and has the advantage of bringing broad surfaces together.

In applying a suture, it is a good plan first to fix a thread at each end of the incision, by which the wound may be steadily held in view during the application of the intermediate stitches. Some operators have advised that the outer surface of the bladder wall be dissected off for a short distance around the incision, in order to prepare a fresh, raw surface which shall readily unite when drawn together by sutures. Antal suggests that an oval surface be thus denuded before the cavity of the bladder is opened, and that the incision be then made in the middle of this refreshed area. Whatever plan is used, great care should be taken that none of the stitches penetrate the cavity of the organ, for not only would they favor escape of urine and thus make first intention almost impossible, but they would also be likely to serve as a nucleus around which calcareous deposits would form.

When the bladder wound is sutured, provision has to be made for the escape of urine, either by passing a catheter through the urethra and securing it there, or by putting a tube out through the perinæum. The latter plan affords the best drainage, but involves an additional operation. Keyes has sought to reduce this operation to a minimum by the following procedure: He passes a sound from the bladder into the membranous urethra, and, making its point prominent in the perinæum, cuts down upon it by a very small incision. Through the opening thus made a probe is passed up into the bladder, which draws after itself a thread, which in turn pulls in the catheter.

The other plan for the treatment of these wounds, and the one which thus far has had the most success, is that of keeping the wound open and draining the bladder through it. It is well to use two tubes for this, and their ends should be carried down to the bottom of the bladder when it is collapsed in the pelvis, after the rectal bag has been removed. The use of the two tubes is a safeguard against the escape of urine being stopped by clots, and they are useful for irrigation. They should be secured to the skin, and their ends should be left long enough to dip down into a bottle between the thighs; or, if preferred, they may have attached to them a longer piece of tubing, which hangs down over the side of the bed and acts as a siphon to draw the urine out of the bladder. Some operators prefer to keep their patients on the side or belly, to favor drainage, but this is usually not necessary

After thorough irrigation, the wound should be dressed antiseptically, with iodoform gauze covering it closely around the tubes, and an absorbent dressing outside of this. For the first few days the bladder may be irrigated with a solution of boracic acid several times in the twenty-four hours. After a few days one tube may be left out and a catheter tied in. When this is working satisfactorily, and after the wound has contracted pretty well, the remaining tube may be removed, and the suprapubic wound soon closes.

**Accidents and Complications in Suprapubic Lithotomy.**—**Rupture of the Bladder.**—The over-zealous distention of the bladder has led to rupture in a number of instances. Although this accident is most apt to occur in the weakened, sacculated bladders of old men, still it has happened in some instances in children. It is to be borne in mind that the pressure in the bladder is very considerably increased as the rectal bag is filled, and as much care should be exercised in the distention of this as in that of the bladder.

Especially is this care of importance, in view of the fact that the rectum itself has been ruptured not a few times by over-distention, and fatal results have followed. The knowledge that these accidents may happen should be a sufficient safeguard against their occurrence in skillful hands, except in conditions of weakness which could not be suspected.

**Septic Infiltration.**—This is a complication that may arise in the wound. The precautions that should be taken against it should comprise, first, the preliminary purification of the urine by internal medication and by irrigation; secondly, the thorough observance of antiseptic methods during operation; and, lastly, the adequate provision for drainage subsequently. The loose, cellular spaces about the neck of the bladder should be disturbed as little as possible during the operation, for pockets are easily created in it by too much handling, and the way is thus prepared for penetration of urine into the deep parts.

## STONE IN THE FEMALE BLADDER.

A stone forms in the female bladder far more rarely than in the male. This is due in part to the anatomical arrangement of the parts. Through the soft and distensible female urethra small renal calculi which reach the bladder, and sand and gravel which form there, are quickly and easily passed. Moreover, the rarity of stricture in the female urethra, and the absence of any prostate to cause obstruction by enlargement, make the occurrence of retained (residual) urine very infrequent; and this fruitful cause of fermentation and consequent formation of secondary stones in the male is therefore not so active in the female. On the other hand, women are subject to hysteria, and the short urethra is favorable to the introduction of foreign bodies about which calculi may form.

After operation upon a vesico-vaginal fistula a stone may form either as an incrustation upon granulations projecting into the bladder at points where the mucous membrane has healed imperfectly, or a wire stitch may serve as a nucleus. If a stitch cuts through one margin of the wound and remains attached to the other, its end may fall within the bladder and the opening may close outside of it, leaving it projecting into the vesical cavity. I have met with one such case in which two stitches thus escaped skillful operators, and in which a tendency to stone formation persisted until they were discovered and removed.

Instances are reported in which large stones have by ulceration gradually worked their way through the vaginal septum and have thus escaped; in other cases they have gradually worked their way out along the urethra by a process of combined dilatation and ulceration, and have thus finally been expelled. Stones thus voided have reached a weight of from two to twelve ounces. Keyes gives an account of many such. In most of the cases incontinence has followed, but Agnew reports a case of spontaneous expulsion of a stone through the vagina, in which, though the calculus was as large as a goose-egg, no incontinence remained; and in another case, mentioned by Keyes, a stone having a circumference of five inches was passed by a woman of eighty years, and only temporary incontinence followed.

Instances are recorded in which a stone has proved a serious obstacle to labor, and in which both mother and child have been lost through this complication.

The *symptoms* of stone in the female do not differ essentially from those observed in the male, although an appreciation of their significance may be interfered with by the coincidence of uterine or other pelvic disorders. In the case above alluded to, in which stones formed on wires projecting into the bladder, it was noticeable that as long as the stone remained attached to the wire in the vesical wall it did not give rise to characteristic symptoms; but, the moment it became detached, all the symptoms were at once present in their intensity.

The *physical* examination for a stone in the female bladder is an easy one. If large, it may be made out by vaginal touch, and with a finger in the vagina and a sound in the bladder, all parts of the vesical cavity may be thoroughly searched.

**Operative Treatment.**—The only methods of removal of stone from the female bladder that meet with modern approval are: 1. Dilatation of the urethra. 2. Litholapaxy. 3. Vaginal lithotomy. 4. Suprapubic lithotomy.

**Dilatation of the Urethra.**—This method is applicable to the treatment of small stones. Bryant states that stones up to two inches in circumference may be thus removed without causing incontinence; and Keyes places practically the same limit when he says that he has dilated up to a diameter of three quarters of an inch.

If the urethra is dilated further than this, the fibers of the sphincter are apt to be ruptured and incontinence to result, so that for stones which, when in the grasp of the forceps, have a diameter greater than three fourths of an inch, it is best to choose some other method.

The dilatation may be carried out first with large sounds or uterine dilating stems, and then with the fingers, if they are sufficiently slender. Keyes has found the dilator of Dolbeau a convenient instrument. Having attained a sufficient degree of dilatation, a slender pair of forceps may be introduced and the stone seized and removed.

**Litholapaxy.**—This operation is easily performed in woman, and is to be chosen for the great majority of stones. Even those small enough for removal through the dilated urethra may best be treated by crushing, which causes even less injury of the parts.

In using the lithotrite it is usually convenient to have the patient in the lithotomy position. The contour of the bladder is now to be remembered, for in woman the presence of the uterus behind the bladder makes the posterior wall of the latter irregular and flatter than in man, so that the fragments lying upon it do not naturally gravitate to the center, as in the male bladder.

Difficulty in seizing the fragments will then be met, if the handle of the lithotrite is held at an angle of forty-five degrees with the horizon. To obviate this, the instrument should be held almost vertical. The blades then rest on the yielding vaginal wall, close to the urethral opening, and depressing this they make it the most dependent part of the bladder, into which fragments gravitate and where they may be readily seized. Occasionally, in cases of difficulty, the fingers may be used to raise the vaginal septum, and thus to bring the stone into reach.

For the evacuation of the *débris*, a short, straight tube should be used, and if the urethra is distensible, one of good caliber may be chosen. If there is reason to believe that a stitch remaining from a vesico-vaginal operation is the cause of the stone, a careful search should be made along the line of the cicatrix. This may well be done with the forceps or sound in the bladder and the finger in the vagina. In the case alluded to, one stitch was felt and removed through the vagina, and the other, which could not be felt, was finally, after a long search, caught with the forceps in the bladder and twisted away from its attachment. The granulations which may exist along the vesico-vaginal scar should be thoroughly curetted away.

Litholapaxy may seem unsuitable if the stone is too large or hard to crush, or if it is too tightly grasped by the bladder to allow of the manipulation of instruments. A foreign body too large to come through the urethra, and resistant to crushing, may require lithotomy; and an encysted stone which can not be dislodged with the lithotrite must be reached by cutting. Occasionally other conditions may coexist, such as a tumor or an inveterate cystitis, which are treated by an opening into the bladder, and the removal of the stone is incidental to this operation.

**Vaginal Lithotomy.**—This is a comparatively safe operation, and is suitable for any of the conditions enumerated as not proper for litholapaxy. It is so simple an operation, and so much in the line of gynæcological work, that it is frequently chosen by gynæcologists into whose hands cases of stone have fallen, even when litholapaxy might be applied. The possibility of a persistent fistula, or of the subsequent formation of stone on stitches or granulations, as well as the greater severity of the operation and the length of time required for convalescence, should all be considered before choosing this operation needlessly.

The operation may be done with the patient on the back, or in Sims's position. The vagina is held suitably open with specula; a sound is introduced into the bladder, and the tip is made prominent against the vesico-vaginal septum just within the bladder. The wall of the vagina is then steadied with tenacula or forceps, and an incision is made directly down on the tip of the sound. This opening may be enlarged by scissors and by stretching till it is large enough for the removal of the stone. If the stone is very large, it may be crushed *in situ* and removed piecemeal.

The wound in the bladder may then be at once closed by stitches, or it may be left to heal spontaneously, any fistulæ which remain being afterward closed by operation. If this plan is followed, the vagina and bladder must be constantly washed out, to prevent phosphatic incrustation of the wound.

The tendency to spontaneous healing is so great in some cases that, where it is desired to keep up bladder drainage for a time, Emmet advises attaching the mucous membrane of the bladder and vagina together around the incision, thus making the opening permanent until it is thought wise to close it by operation.

**Suprapubic Lithotomy.**—Rarely it may happen that a stone is too large for vaginal lithotomy and too hard for crushing. In such a case a suprapubic incision may be chosen.

A colpeurynter in the vagina might be of assistance in this operation, but I am not aware of any instance of its employment. The technique is the same as in the operation on the male bladder.

## II. PROSTATIC CALCULI.

The prostatic urethra at times contains concretions which, originating in the kidneys or bladder, have lodged in the prostatic sinus. These will be considered under the head of "Stone in the Urethra." Besides these, there are to be found in the prostate stones which have their origin in the gland, and which are wholly distinct from the other urinary calculi.

The so-called *corpora amylacea* are almost constantly present in the glands and ducts of the prostate. In a series of one hundred prostates examined by Thompson, these bodies were found in every instance. In the younger prostates they were of microscopic size, while in older organs they were almost always visible to the naked eye. These are quite different from the bodies of the same name that are found in the brain. They are yellow, brown, or black in color, and are apparently formed by the inspissation of the prostatic secretion. They are usually so small as to give rise to no symptoms, but occasionally they have lime salts deposited in them, and may then grow very considerably in size and give rise to much trouble. Thompson regards the deposition of lime salts in them as evidence that they are felt by the surrounding tissues as foreign bodies, and, by the irritation that they cause, lead to the precipitation of lime about them.

They exist either in an isolated form, each calculus occupying a little pocket of its own in the gland, or, not uncommonly, several concretions may lie together in a single pouch. In this case they are closely applied to each other, and fit together with corresponding facets. Sometimes they coalesce to form composite stones. In this way large calculi result, and they may even project back into the bladder.

The salts of which these prostatic calculi are made up are the phosphate and carbonate of lime. They are very hard, and have a smooth, polished surface like porcelain, which distinguishes them from the rougher urinary calculi. When they lie in pockets connecting with the urethra, so that the urine has ready access to them, they may become coated with other urinary salts. In this way mixed calculi result, which may attain great size. Thompson cites four instances in which a large number of such calculi were removed from pouches which they had formed for themselves in the prostate and surrounding tissues. They sometimes by irritation give rise to suppuration, leading to an abscess in the prostate which may open into the urethra or may perforate the gland in some other direction; the pus may appear in the perinæum, or may break into the rectum or bladder.

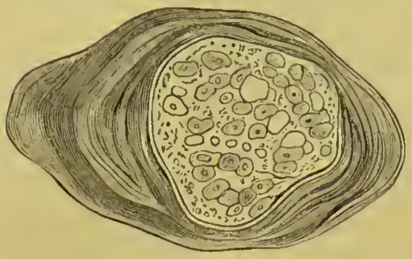

Fig. 85.—Prostatic calculus. Showing the granular, nucleated centre surrounded by laminated layers.

The symptoms arising from them are those of prostatic irritation, and if they press or encroach upon the prostatic urethra they may lead to obstructive symptoms such as are present in enlarged prostate.

**Diagnosis.**—It is extremely difficult to determine the existence of one of these calculi in the prostate, unless some portion of it so projects into the prostatic urethra that it can be detected with the sound. Occasionally their presence may be suspected when, by the rectal touch, very hard bodies are felt in the substance of the gland, especially if these are observed early in life, before hard, fibrous growths are likely to appear in the prostate. If abscesses have already formed about the stone, and have broken or been opened externally, a search with a probe through the fistulous openings that are left may lead to the discovery of calcareous matter.

**Treatment.**—The only treatment of these cases is either by palliation or operation. The stone should always be removed if the patient is in fit condition for surgical interference.

It may rarely happen that the stone projects so far into the prostatic urethra that it can be pushed back into the bladder and there crushed. Usually, however, the stone is so inclosed in the prostate that it can not be dislodged or reached through the urethra, and can therefore only be removed by incision.

The *median operation* is the suitable one for these cases, for it affords a direct route to the stone, and usually gives sufficient room for its removal. If the stone is too large for removal through the median opening, a lateral or bilateral incision may be used. If the stone lies wholly in a pocket in the prostate, the bladder will not be entered by the operation. It should always, however, be explored, to see whether it contains a urinary calculus as well.

## III. STONE IN THE URETHRA.

It is a rare occurrence to have a stone originate in the urethra. Occasionally calcareous salts (phosphates and carbonates) are deposited on ulcerated patches in the urethra posterior to a stricture, and these may accumulate till they assume the proportions of a stone. In the same way stones may form in pockets, glandular or otherwise, communicating with the urethra, in which the urine stagnates.

Usually, however, stones which are found in the urethra have been formed either in the kidneys or bladder, and have been arrested in the urethra during their passage outward. This arrest takes place either at a point of physiological narrowing, or behind a stricture which has resulted from previous urethral disease or injury.

The prostatic sinus, the membranous urethra just behind the opening through the anterior layer of the deep perineal fascia (triangular ligament), and the fossa navicularis are the more common points where stones lodge. At the peno-scrotal angle is also a slight narrowing that may catch a stone, which has successfully passed to this point.

If the stone completely fills the urethra, it may cause a stoppage of water, and this forced retention may lead to great distention of the bladder. This course of things is favored by the tendency of the urethral walls to close spasmodically upon any foreign body that acts as an irritation to them. After the overfilling of the bladder and the urethra behind the stone becomes extreme, the urine usually finds its way past the stone, and a constant dribbling is the result of this overflow. Keyes has recorded such a case.

When the stone does not completely fill the urethra, or if it lies in a pocket to one side of the canal, it may be carried for a term of years without leading to any serious condition of things. Under less favorable circumstances it causes ulceration, and may lead to an abscess, or even work its way out and be discharged externally.

Sometimes several stones are found in the urethra at one time. In the Warren Museum of the Harvard Medical School is a set of calculi, four in number, removed from the urethra by Dr. J. T. Boutelle, of Hampton, Va. The patient was a negro, and had had discharging fistula in the perinæum for ten years. They are of a glossy surface, of porcelain-like hardness, and articulate one with another by ball-and-socket joints in a very beautiful manner. Several stones may exist together in pockets alongside of the urethra. They are then faceted, much like those which form in a similar way in prostatic pouches.

**Symptoms.**—The symptoms caused by urethral calculi vary greatly. If a renal or vesical stone enters and is stopped in the urethra, it produces a sudden painful stoppage of the urine that is very characteristic. On the other hand, slowly forming stones make their presence known by the irritation and partial obstruction that they cause.

If they are situated in the anterior part of the canal, they do not usually affect the frequency of urination, and may be accompanied by but little pain. When, however, the stone lies in the prostatic urethra, particularly if portions extend back into the bladder, the tenesmus and pain may exactly resemble what is seen in stone in the bladder.

**Diagnosis.**—This can usually be made sure by a physical examination. All parts of the urethra are accessible to the finger, either from the outside or through the rectum. The stone is felt as a hard body somewhere in the course of the canal, and a sound passed down to it shows it to be calcareous. When it has ulcerated its way into a side pocket, there may be difficulty in bringing the sound into contact with it, even by combined manipulation with a hand on the outside. If it lies in an abscess which has opened externally, a probe will usually touch the stone through one of the fistulous openings.

**Treatment.**—An attempt may be made to wash the calculus along by an over-forcible expulsion of urine. Keyes suggests that under the relaxation of an opiate and a warm bath the stream be stopped suddenly during urination by compression of the meatus, and says that in this way the anterior urethra, being dilated, may provide room for the passage of the stone. When this manœuvre does not succeed, resort should be had to surgical interference.

A small stone or fragment, recently arrested in the anterior portion of the urethra, may perhaps be worked forward and moved along the canal by manipulation. It sometimes crumbles under the fingers, and is then washed out with the next passage of urine. If it is not thus readily dislodged, it must be removed either by instruments passed along the canal or by incision.

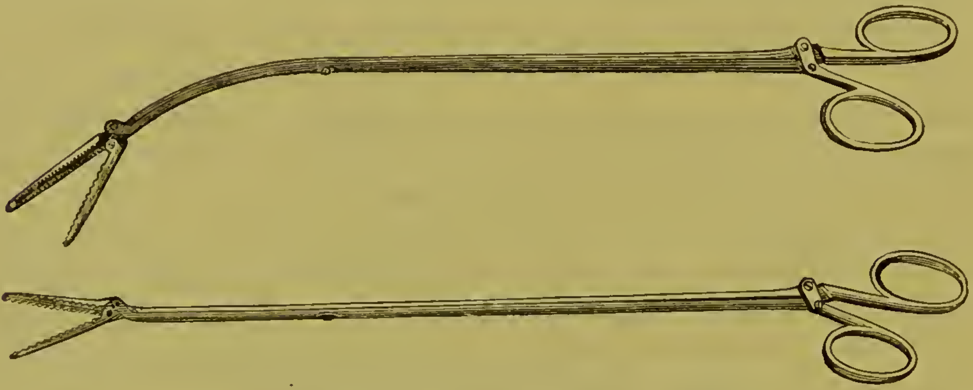

Fig. 86.—Alligator forceps, curved and straight.

A sound passed down to the calculus, and then hastily removed while the patient passes urine, may so distend the passage in front of the calculus as to allow of its being driven out. If this fails, attempts may be made to seize and draw it out.

The instruments to be used along the urethra are the alligator forceps or the urethral scoop. The stone should be held steady with the fingers outside, while trying to grasp it with the forceps, or when passing an instrument, designed to act as a scoop, beyond it.

Keyes describes an ingenious use of Thompson's urethral dilator in accomplishing the removal of a calculus from the urethra. The slender shaft of the instrument is split and may be separated by screw force. When this is carried down past the calculus and then forced open, the stone falls between the two parts of the shaft, and in closing them again it is firmly held, and may be withdrawn. He gives the credit of the first use of this expedient to Dr. Westmoreland, of Georgia, although he was himself not aware of its previous use when he first employed it.

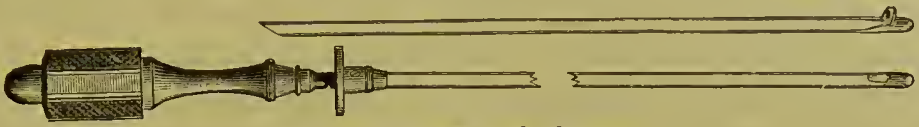

Fig. 87.—Leroy's urethral scoop.

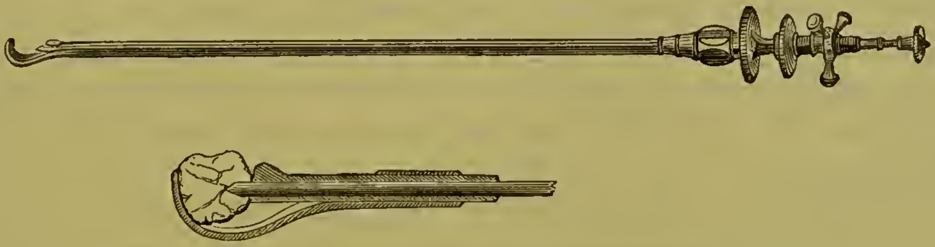

Fig. 88.—Reliquet's urethral stone-crusher.

When a stone is lodged in the urethra posterior to the constrictor muscle, it may be possible to push it back into the bladder, where it can be crushed. A large sound may be used for this purpose, or an evacuating tube. The use of this has been described. (See Litholapaxy.)

When a stone is so fixed in the urethra that it can neither be drawn out nor pushed back, or when it is located in a pocket to one side of the urethra, it must be cut down upon and removed. Incisions made for this purpose usually heal well. It is better practice, I think, to remove them thus than to try to crush them *in situ*. Urethral lithotrites work in too confined a space, and are apt to lacerate the surrounding parts.

## IV. STONE IN THE URETER.

The stones which lodge in the ureter and lead to trouble there have their origin in the calyces and pelvis of the kidney, and are carried down with the stream of urine. A stone never forms in the ureter unless it has a foreign body for a nucleus, but concretions may increase in size while arrested there. Usually renal calculi of small size and smooth surface, when they once get started along the ureter, find their way down into the bladder. Occasionally, however, when of large size or of a prickly, irregular surface, they are caught in the canal and remain there for a longer or shorter time. Even comparatively small stones, if of sharply angular shape, may become thus fixed. For not only do the sharp projections catch in the mucous membrane and thus hinder their progression, but by their irritation they may, as M. Le Dentu suspects, excite the ureter to a contraction that holds them fixed. It is also probably true that their irregular shape prevents their so closely stopping the ureter that the urine collects behind them. This would render inoperative one of the most efficient agencies by which their progress downward is effected. For it is the gradually accumulating pressure of the retained urine that forces the concretion along the canal, and, if the urine constantly leaks past the stone, the accumulation behind it is impossible.

A calculus may be arrested at any part of the ureter, but there are certain points where this arrest is likely to take place. First, at the entrance of the pelvis into the ureter, there is a narrow place, and a calculus too large to enter is apt to become impacted here. Also, about two inches below this there is a point at which calculi are prone to lodge. The writer has met with one instance of this sort.

Farther down, just below the brim of the pelvis, there is often a slight narrowing; and, lastly, as the ureter perforates the bladder wall it penetrates first the muscular coat, then running for from one half to three quarters of an inch between that and the mucosa, it finally opens through the mucous membrane on a little nipple-like projection into the cavity of the bladder. Just in this portion of the canal calculi frequently become fixed. Numerous instances are reported in which they have been removed from this point.

Occasionally the ureter contains more than one stone; for, as it is not unusual to see several calculi in the kidney, it will sometimes happen that one stone working its way down and dilating the ureter prepares a way which others easily follow. It also sometimes occurs in calculous patients that both ureters will contain stones at the same time.

When a calculus becomes fixed in the ureter it produces effects both general and local. Its general effects are brought about by its mechanical obstruction to the flow of urine, and also apparently in some cases through the reflex effects of the irritation. Thus it has happened that a calculus lodged in one ureter has led to complete suppression of urine, owing, first, to the stoppage of one kidney; and, secondly, to the inhibitory effect produced upon the other. If the kidney whose ureter is stopped has a partial outlet for the urine, either intermittently or constantly, by the leakage past the stone, its function is usually not destroyed, although much interfered with. In such a case we may have a simple hydronephrosis, or an inflammatory process may establish itself in the kidney, and this may either take the form of a pyelitis, and lead to a pyonephrosis with perhaps a pyelonephritis, or the kidney substance may be mainly affected, and we then have a parenchymatous or interstitial nephritis.

When, however, the stone produces a complete stoppage, we have an effect much like that which follows the ligature of the ureter, and with the greater or less formation of a hydronephrosis the secreting portion of the organ is gradually destroyed. The writer has met with such a case, in which a kidney that had been subject to attacks of renal colic from the passage of stones for many years, had its ureter finally completely blocked by a large calculus, and in consequence lost its secreting power, so that when the stone was removed urine no longer came from that side. Usually, under these circumstances, the remaining kidney becomes hypertrophied and performs the functions of both. It is a not uncommon circumstance, however, in the existence of a calculous diathesis to finally have the ureter of the remaining kidney suddenly blocked, and complete suppression result.

The pain which a stone causes is also to be taken into account among its serious general effects. This is sometimes so severe and prolonged as to gradually wear a patient out with nervous exhaustion and loss of sleep. Under these circumstances, a long-delayed operation will have less chance of success than one undertaken while the patient's forces are well preserved.

Besides these general changes which lead to a partial disabling of the urinary excretory organs, a stone lodged in the ureter produces also serious local lesions which may gravely affect life. When a stone thus becomes fixed the first effect is a stretching of the ureteral walls, making them thinner; and if at the same time the irritation of the stone sets up an inflammation, they may be perforated, and the escape of urine and even of the stone into the parts about may lead to the formation of an abscess.

If, however, the pressure and irritation of the stone do not lead to perforation, the walls of the ureter gradually become thickened by the formation of fibrous tissue in and around them. At the same time the ureter behind them is subjected to an increase of pressure proportionate to the degree of completeness with which the calculus stops the flow of urine. The canal is dilated, and if this condition of things persists, the walls gradually become thickened. Especially is this the case when a suppurative inflammation of them is set up.

Not uncommonly a stone, after lodging for a time, moves on before the accumulating pressure behind it, and, again lodging, sets up the inflammatory changes of the wall at this new place. Thus a ureter through which many calculi have passed may be much dilated and thickened through its whole extent, with here and there points of comparative narrowing where more active irritation has set up a peri-ureteritis and consequent stricture.

The abscesses which occur in connection with impacted stones may, as has been said, appear soon after the impaction of the stone, but usually do not form till late, after the wall of the ureter has been weakened by a slow process of ulceration. The pus may find its way in several directions. Spreading in the loose connective tissue behind the peritonæum, it may run down into the pelvis about the bladder, or it may find its way upward and even penetrate into the pleural cavity, or open into a bronchus. Posteriorly it may perforate the muscles and point in the back, or anteriorly it may open into the colon—a coil of small intestine—or even into the general peritoneal cavity.

**Symptomatology.**—The pain caused by the impaction of a stone in the ureter is the most characteristic symptom of the condition. Coming as a sudden attack of nephritic colic, it is felt in the side and back, or may be referred to the abdomen. Of a severe, lancinating character, it shoots downward toward the bladder, or into the scrotum and thigh. If the calculus enters the ureter and works down, the pain may sometimes be felt to shift downward, but this is not always the case, as the pain in the kidney often remains severe as long as the ureter is blocked. The pain is usually associated with a frequent desire to urinate.

When the stone becomes fixed at some point, the pain may gradually abate in severity, and may take on an intermittent character, periods of comparative comfort being interrupted by attacks of pain, recalling that of the first onset in their severity.

Nausea and vomiting are the usual accompaniments of the severe attacks. An examination of the urine will commonly reveal the presence of blood and albumen, and later pus-cells are also present. If the stone wholly occludes the ureter, so that no urine comes from the affected side, these evidences may be absent, and the urine will then appear quite normal in character but scanty in amount.

As has been said, the stoppage of the ureter is at times partial or intermittent. It is well, therefore, to save the urine from each micturition in a separate glass. A comparison of all the specimens thus collected through the day will often show great variations in quality, some of them being quite clear, while others are clouded by the presence of blood and pus. Even when all of them are cloudy there may be considerable differences in the amount of sediment in the different glasses.

The quantity of the urine in twenty-four hours should always be carefully watched, and the search for casts and albumen should be frequently made. There is usually but slight fever at first in these cases of impacted stone; but if inflammation is set up either in the kidney or in the parts about the stone, the temperature becomes elevated. The formation of an abscess gives the daily fluctuation of temperature characteristic of suppuration.

**Diagnosis.**—The diagnosis of a stone in the ureter is not always an easy one to make; for, while the pain of renal colic is usually very characteristic, it sometimes lacks salient features and is not easily recognized. Moreover, when the pain is obviously caused by an obstruction or irritation in the ureter, it is not even then always easy to determine that the cause is a calculus, for the passage of sand or of clots of blood or mucus through the canal, the pressure of growths from without, or the existence of a stricture in its walls, may give rise to an almost similar train of symptoms, and the differential diagnosis can only be made by a painstaking study of each case, and is then not always feasible. The possibility of confusing these cases with some obstructive lesion of the bowels should not be lost sight of. If the pain is most felt in the abdomen, the accompanying vomiting, and the constipation which almost certainly follows the exhibition of opiates, combine to form a very misleading picture, and the careful examination of the urine must be relied on to prevent a mistake. For purposes of treatment it is also important, after the presence of a calculus is assured, to make out, if possible, the exact seat of the concretion, and for this we must rely on a very careful exploration.

**Physical Examination.**—Unfortunately, the greater part of the ureter lies so deeply that it can not easily be explored by the touch. The lower part of the canal can be reached through the vagina in woman, and by the rectum in the male, although even this is impossible in the case of a fat man with a thick perinæum. Palpation through the vagina is not difficult, and the stone can usually be recognized in the last two or three inches of the ureter. The portion of the male ureter that can be reached through the rectum is much less considerable than this, probably not often more than the last three quarters of an inch, that lies in the wall of the bladder, being accessible.

Palpation through the abdomen may be successful in a thin subject, especially if the stone is a large one. In a fat patient, or with a small stone, this search would probably be fruitless. In case the stone has so blocked the ureter that a hydro- or pyonephrosis has formed behind it, the upper dilated portion of the ureter may sometimes be felt below the enlarged kidney, and the site of the stone would naturally be at the lowermost point of this swelling.

Even when nothing can be felt by the examiner the probable seat of the stone may sometimes be determined by the patient's sensations to palpation. A constant tender spot over one part of the canal is always suggestive of the seat of the stone. The pain at such a point is usually of a pricking character, and is especially to be elicited by a sharp push of the fingers. When a stone is lodged in the upper part of the ureter the tender point may also be sought in the lumbar region, and the writer has succeeded in removing a stone from this portion of the canal which was located by such a point of tenderness in the back. When the indications do not point with sufficient distinctness to any one spot, and the condition of things is so serious that some interference is demanded, the position of the stone may be sought by an abdominal incision. With the hand in the abdomen, the whole course of the ureter can be easily palpated, and the stone thus discovered. Recently it has happened to two operators * to successfully locate a stone in this manner, and in each case to remove it with good results.

**Treatment.**—The treatment of these cases may be divided into preventive, non-operative, and operative measures.

The *preventive* treatment, directed in general against the calculous diathesis, is considered at length in the article on Stone in the Bladder.

The *non-operative* treatment has for its object, first, the relief of the pain, and, secondly, the furtherance of the passage of the calculus through the canal.

The pain is often so severe that full opiates fail to give relief. As vomiting is apt to occur, and as the absorption through the stomach is thus rendered uncertain, it is well to give morphia subcutaneously, so that the exact quantity administered may be known and the absorption may be rapid. It is also to be borne in mind that the pain may at any time cease if the calculus escapes into the bladder. This cessation of pain at once removes a powerful antidote to the morphia, and an amount of the drug which was producing no toxic symptoms may, after this relief, throw the patient into a profound and dangerous coma. The severity of the pain and the danger of over-administration of morphia make it wiser often to use anæsthetics by inhalation; and sulphuric ether may be used continuously or intermittently for many hours when necessary. Locally the application of heat, dry or moist, is of use in mitigating the sufferings, and may assist in relaxing spasm. The passage of the calculus along the canal may be helped by the liberal ingestion of water, and this is also useful in keeping up the action of the kidneys and preventing the suppression of the urine.

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* Hall, N. Y. Med. Record, October 18, 1890; Lane, London Lancet, November 8, 1890.

When the amount of urine is decidedly diminished, diuretics may be required. Those which are not irritating to the kidneys should be selected. Sugar of milk, in doses of one drachm, of a saturated solution every two hours, or diuretin, gr. x, frequently administered, will sometimes be of service. The citrate and acetate of potash may be tried also, but the liberal administration of water is perhaps the most efficient means of keeping up the action of the kidneys. Local counter-irritation by mustard poultices and hot fomentations over the kidneys will greatly assist in promoting their action.

Whether solvents, such as the salts of lithia or piperazine, can have any effect in reducing the size of an impacted stone, is doubtful, but they may be properly given in the hope of breaking up a loosely made concretion, and of bringing into solution crystals that would otherwise be deposited upon it. Supporting measures, to assist the strength of the patient to hold out under the strain of extreme pain, should not be neglected.

**Operative Treatment.**—Before proceeding to the consideration of serious measures for the relief of a stone in the ureter, it will be well to consider the history of these cases somewhat carefully, and to endeavor to lay down some rules by which we shall be decided when to operate and when to let the case alone, and leave it for the efforts of Nature to cure.

When we have a condition of high fever, with other indications of the formation of an abscess around the calculus, our duty is clear to open the abscess and remove the irritating cause. Also, when the obstruction has led to a pyonephrosis with a gradual loss of the patient's strength and flesh, the indications for the surgeon are again plain, and an operation should not be delayed.

On the other hand, it is not easy in acute cases to determine at first which ones are likely to go well to a successful issue, and to result in the final expulsion of the stone, and which must be assisted by operative measures. If in such a case the amount of urine becomes dangerously small, and especially if the presence of albumen and casts in that which is passed indicates a serious implication of the kidneys, an operation should be undertaken at once.

It is to be remembered, that if one kidney contains stones it is not improbable that the other does also, and that the added work is being borne by an organ already partly disabled. The serious impairment of a kidney whose ureter is blocked, and the possible permanent deterioration of so important an organ, should not be lost sight of, and full weight should be given to these considerations in deciding for or against operation. If an enlargement of the kidney and of the ureter above the seat of the calculus can be made out, it is to be inferred that the stoppage is quite complete, and that the kidney is sure to suffer.

If, on the other hand, the urine finds its way past the calculus, an examination of that passed will tell us whether the kidney is undergoing injury. When the urine is at times clear and then again clouded by the presence of pus and blood, showing that the stoppage on the affected side is complete at times, an examination of the clear specimens will tell the condition of the other kidney, while in the cloudy specimens will be found evidence as to the state of the kidney on the affected side.

While it is undoubtedly true that a calculus will occasionally remain fixed for a long time in the ureter without giving rise to serious symptoms, the fact that it almost inevitably leads to a gradual deterioration of the kidney makes its removal when firmly impacted always desirable. It may sometimes be questioned whether the operation is too dangerous to be undertaken, or is justifiable under the circumstances in an individual case.

These operations have not been done in a sufficient number of cases to establish any ratio of mortality, and the decision must be based upon general surgical principles. Certain parts of the ureter are much more difficult to reach than others. That portion lying in the true pelvis has been hitherto thought inaccessible, but in a recent paper (in the American Journal of the Medical Sciences) the writer has endeavored to show how all parts may be reached; and as some of the procedures in the plan proposed have not yet been tried in actual practice, they are presented here merely as anatomical suggestions, which, when tested by dissection, seem to have some value.

In deciding upon the best method of operation, we have before us an anatomical problem, which is, How can the ureter be reached and opened in the different parts of its course without injury to the peritonæum?

This is one of the cases in which it seems unwise to conduct the operation through the abdominal cavity; for, although the canal can be easily reached and examined through the abdomen, and although the removal of the stone in this manner would be a comparatively simple matter, yet the condition which would be left of an intraperitoneal wound of the ureter introduces so much danger of urine leakage into the abdomen that surgeons have for the most part avoided it, and have sought to reach the canal extraperitoneally. The opening of the abdomen for the purpose of locating the stone and thus properly guiding the extraperitoneal incision is quite a different matter, and of undoubted value.

By what incision, then, can we best reach the ureter extraperitoneally? Let us glance a moment at its anatomy.

The ureter, leaving the pelvis of the kidney by a funnel-shaped opening, runs downward on the anterior surface of the psoas muscle, crosses the common iliac artery and vein at the entrance of the pelvis, and then, running in Douglas's fold of the peritonæum, converges toward the opposite ureter and enters the posterior walls of the bladder. Here, in the male, it crosses the vas deferens. In the female the ureters pass around the neck of the uterus to reach the bladder. As the ureters approach the pelvis in the lower part of their course through the abdomen, the left ureter lies close to the spine and in the angle between the bodies of the vertebræ and the psoas muscle. On the right the ureter is somewhat separated from the spinal column by the interposition of the vena cava inferior. The vein and ureter lie in close apposition.

While this description serves as a fairly reliable guide to the ureter in most parts of its course, still, in a surgical search for the canal deep in the tissues, particularly if the subject be a fat one, it is extremely hard to find the lax tube and to recognize it in its collapsed condition. Anything, therefore, which enables the surgeon to locate the ureter more exactly may be of great aid in his search.

There is a relation of the ureter to the peritonæum a knowledge of which will greatly simplify this search. This is, the fact that the ureter is adherent to and always separates with the peritonæum, as it is stripped up from the parts behind. The reason of this adhesion of the ureter to the peritonæum may be seen upon microscopical sections across a ureter separated with its peritonæum. It will be found that the ureter is more or less closely bound to the under surface of the peritonæum by fibrous bands, and thus this intimate connection of the ureter to the membrane over it is explained. Moreover, the relation of the ureter to that part of the peritonæum which becomes adherent to the spine is, within a slight range of variation, pretty constant, the ureter lying just outside the line of adhesion ; so that, if the surgeon has stripped up the peritonæum and come down to the point where it refuses to strip readily from the spinal column, he will find the ureter upon the stripped-up peritonæum at a short distance outside this point. On the left side the distance from the adherent point to the ureter is from half an inch to an inch, while on the right side it is somewhat greater, owing to the ureter being displaced to the outside by the interposition of the vena cava between it and the spine.

If now a stone is lodged in the abdominal portion of the ureter, it may be reached by an incision on the line mapped out by Israel, which starts at a point on the anterior edge of the sacro-lumbar mass of muscles, a finger's breadth below the twelfth rib, is carried parallel to the rib as far as its tip, then turns down toward the middle of Poupart's ligament till the line of usual incision for tying the iliac artery is reached, then again turns toward the middle line, and ends on the external border of the rectus muscle. According to the seat of the calculus, the incision will be made on the posterior, middle, or anterior third of this line.

In the first three inches of its course it may also be reached by an incision along the outer edge of the quadratus lumborum muscle, and this opening gives sufficient room for examination of this part of the canal, except in cases where the ribs and iliac crests are unusually near together. The dissection should be quickly carried down to the peritonæum, and this membrane should be separated from the parts beneath, the finger pushing readily in behind it. The ureter, as has been said, adheres to the peritonæum and is lifted up with it.

The relation of the ureter upon the right side to the vena cava inferior should be remembered, and care should be taken in searching for it. If a stone is impacted in the ureter, it can usually be easily found by palpation through the wound, and this greatly simplifies the search for the canal. In the upper part of the pelvis the ureter may be reached by an incision along the lower end of Israel's line, and in a child or thin person it might be accessible in this manner, even to a point behind the bladder. Practically, however, in adults of ordinary development, the lower three or four inches of the canal can not be reached through an extraperitoneal incision in front.

In one case (Lane, *loc. cit.*) in which an incision had been made into the peritoneal cavity for the purpose of diagnosis, where a stone had been found in the pelvic part of the ureter, it was found possible with the hand in the abdomen to lift the stone toward the crest of the ilium, where it could be reached by the extraperitoneal incision. This case suggests, and it seems probable, that the combined incision might safely be used in some of these cases where the calculus is otherwise out of reach; and it would even seem possible, in a favorable case, to work the calculus along the ureter by manipulation to a point where it could be reached by an extraperitoneal opening.

When we come to the last two or three inches of the ureter, however, we reach a region which can not be operated upon through the anterior incision. This lower end of the canal, too, is a point where calculi are very apt to become impacted. Occasionally they even project into the bladder, and in such a case they may sometimes be reached and removed either by dilatation of the urethra in the female, or by suprapubic incision in the male, through the bladder. There is always danger, however, if the bladder wall is considerably incised, to release one of these calculi, that urinary infiltration will take place.

In the female, this last two or three inches of the ureter runs for the most part within the broad ligament, and calculi in this region can be removed by an incision through the vault of the vagina. If the calculus is readily felt near the cervix uteri, and the incision is made outward from the cervix toward the side of the pelvis, there is little danger of opening into the peritoneal cavity, and the incision can be readily carried down to the stone. If it lies deeply, the parts may be separated with the finger, until the stone lying in the ureter is reached.

In one such case the writer removed a stone from this region weighing one hundred and ninety grains. The difficult step in the operation was the dislodging of the stone after it was fairly uncovered. This was finally accomplished by passing a blunt hook up over the calculus within the ureter, and by traction upon this, at the same time pushing the tissues aside with the finger of the other hand, the calculus was finally drawn down and delivered.

In the male, the removal of calculi from this region is much more difficult. It would seem possible, however, that it might be accomplished by an incision over the sacrum, with the removal of a part of that bone after the manner practiced by Kraske in cases of cancer of the rectum. Dissections made by the writer show that the ureter is readily accessible in this way.

The incision for thus reaching the ureter may be made over the margin of the sacrum on the side of the ureter which is sought, commencing on a level with the sacro-lumbar articulation, and ending just below the tip of the coccyx. After dividing the sacro-iliac ligaments, the coccyx and the lower portion of the side of the sacrum are removed. This may be readily accomplished with large gnawing-forceps, and, if the side of the bone is cut away as high as the third foramen, a good opening and easy access to the interior of the pelvis are obtained.

In order that the view of the pelvic contents shall be satisfactory, the patient should lie partly on the side, with the abdomen dependent, as in Sims's position. The cavity of the wound is then ballooned out by the pressure of the air, just as happens to the vagina in the examination for which this position is commonly used.

A sound introduced into the rectum now maps out its outline, and serves to hold it to one side during the subsequent search.

The converging lines that the ureters pursue through the pelvis lie pretty closely over the lateral edges of the sacrum, and this relation will help somewhat in fixing their location when approaching them from behind. The normal, collapsed ureter is, under the most favorable conditions, hard to find, and care is required to avoid wounding the peritonæum during the search for it.

In the cases we are considering, however, we have the stone to guide us to it, and, when the calculus is found, an incision may be safely made over its lower surface, which is not covered by the peritonæum.

In some one of these ways we may hope to reach and remove a stone from any part of this deep-lying canal, by incision directly upon it. It may often, however, be easier to make our incision into the dilated pelvis of the kidney, or the upper enlarged portion of the ureter, and then with long forceps to reach and remove the stone. This plan has frequently been resorted to when the surgeon, having opened the pelvis of the kidney, has found that the calculus that he expected to find there is already in the ureter. It might also be a possible means of approach to a stone in the pelvic portion of the ureter, provided the canal above was sufficiently dilated to allow of the manipulation of instruments through it.

Lastly, how shall we treat the wound in the ureter, after the removal of the calculus?

In one case (Lane, *loc. cit.*) it was closed with a continuous silk suture with success. In other cases this has not succeeded; and considering the difficulty of applying a suture, and the possibility that it may serve as a nucleus for future calcareous deposit, this plan would seem to be not without inconvenience and danger.

On the other hand, in several cases the wound in the ureter has healed quickly, without trouble, when left to itself. It would seem, therefore, best not to suture the canal, but to provide adequate drainage for the urine escaping from it till the wound in its wall closes. The only exception to this is when the ureter is opened through the vagina in its lowermost part, where it is in intimate relation with the vaginal wall, and where it is therefore possible to get sufficient thickness of tissue for the application of stitches without encroaching on the cavity of the tube.

# THE SURGICAL DISEASES OF THE KIDNEY.

By LEWIS A. STIMSON, M. D.

## I. WOUNDS AND INJURIES OF THE KIDNEY.

Simon's Chirurgie der Nieren, the two parts of which were published in 1871 and 1876 respectively, was the first attempt to group the various surgical diseases of the kidney, and formally to recognize this branch of the general subject of surgery. Heretofore the only monographs on the diseases of the kidney had been the work of physicians, and with reason, for but little had been done in the way of surgical treatment of such affections as were amenable thereto. The two decades of years that have followed this publication have brought an amount of surgical experience in this department that is simply enormous; our journals and the records of our societies are filled with the reports of cases, and a number of attempts have been made to collect this scattered experience and to treat the subject with more or less completeness and system. The papers and articles that have concerned themselves with certain portions of the subject will be referred to in connection with these portions; those that have sought to cover the entire subject, exclusive of the corresponding chapters in treatises of general and special surgery, are, more particularly, Morris, 1885; Newman, 1888; and Le Dentu, 1889. Of these three, the latter is distinctly superior in orderly arrangement, proportionate distribution of space, and utilization of material coming from all sources. His classification and arrangement have been here adopted, and his work has been made the basis of this article.

Adopting Le Dentu's definition, under surgical diseases of the kidneys we here include all those treatment of which may at any time require surgical or, better, operative interference.

### TRAUMATISMS OF THE KIDNEY.

The principal papers of the last twenty years upon this subject are those of Maas, "Klinische und experimentelle Untersuchungen über die subcutanen Quetschungen und Zerreissungen der Nieren," in Deutsche Zeitschrift für Chirurgie, Bd. x, 1878; Clement Lucas, "On Injuries of the Kidneys," in the Lancet, April 19 and 26, 1884; Edler, "Die traumatischen Verletzungen der parenchymatösen Unterleibsorgane," in Archiv für klinische Chirurgie, Bd. xxxiv, p. 738, 1886–'87; and Edward O. Otis, "Injuries of and Operations upon the Kidney," Boston Medical and Surgical Journal, October, 1887.

Edler collected 152 cases, divided as follows:

| | |
|---|---|
| Subcutaneous injuries of the kidney | 90 |
| Gunshot-wounds of the kidney | 50 |
| Incised wounds of the kidney | 12 |

Of the 90 subcutaneous injuries, 71 were collected by Maas in 1878; the remaining 19 were those reported between 1878 and 1887. The relative frequency, in comparison with injuries of other viscera, is shown by Edler's tables relating to spleen and liver: thus, he collected—

| | | | |
|---|---|---|---|
| Subcutaneous injuries of the liver, | 189; | of spleen, | 83 |
| Gunshot-wounds of the liver | 289; | " | 42 |
| Incised wounds of the liver | 65; | " | 35 |
| Totals | 543; | " | 160 |

Leaving the details of the different classes for later mention, the following may be here quoted from Edler's summary: Shock is present more often and is more severe than after injuries of other viscera; local pain is constant and radiating, especially to the testes; colicky pain is due to the plugging of the ureter by blood; hæmaturia is a common symptom (70 per cent), and often recurrent. The mortality of the 152 cases was 47·3 per cent; of the extraperitoneal cases, 30·4 per cent; of the intraperitoneal, 80 per cent; the most frequent cause of death after subcutaneous injury was primary hæmorrhage, after open wounds, peritonitis or suppurative processes.

## OPEN WOUNDS.

The wound of the kidney may be caused by a bullet or by a sharp instrument, or by a blunt one, as a fragment of shell, the horn of an ox, the prong of a fork, etc. The injury may be limited to the kidney and the overlying soft parts of the back and loin, or it may be complicated by associated injury of the peritonæum and of other viscera, or by the prolapse of the wounded kidney through the wound. Incised and punctured wounds are rare, actually and relatively, and are usually received from behind or from the side, the knife, sword, or bayonet penetrating to the kidney with more or less extensive division of the wall on the way; in some cases it has passed through the lower part of the chest from behind, in others through the anterior abdominal wall. The same is to be said of bullet-wounds, which are much more frequent, and more commonly associated with the injury of other viscera. In cases in which the kidney alone has been wounded the course of the bullet has been oblique from the neighborhood of the median line of the back to that of the anterior end of the eleventh or twelfth rib. In a case that came under my own observation, the bullet entered between the eighth and ninth ribs on the left side in the mid-axillary line, passed through the pleural cavity without wounding the lung, through the upper end of the left kidney, and through the peritoneal cavity to the body of the twelfth dorsal vertebra.

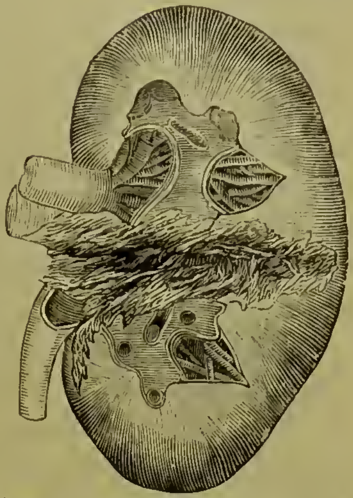
Fig. 1.—Section of a kidney with a shot perforation from before backward.

The injury to the kidney varies from a slight incision to an extensive laceration, with the immediate loss of a large part of the organ; the escaping blood spreads through the adjoining connective tissue and into the peritoneal cavity, if that has been opened, in quantities that vary with the extent and character of the injury; the parenchyma of the organ apparently does not often bleed freely enough to endanger life, but if the larger arterial or venous branches at the hilum have been divided the hæmorrhage may be promptly fatal. If the pelvis of the kidney is opened the blood makes its way into the ureter; if in small amount, it gives rise only to the symptoms of hæmaturia; but if the quantity is large, the blood clots within the ureter, giving rise to colicky pains or to complete obstruction of that organ, or rarely, it may flow freely to the bladder and there form a large clot.

A number of specimens obtained after sufficient intervals show that repair takes place with the formation of a retracted, puckered cicatrix. Tillmanns has sought to show, by ingenious but not very satisfactory experiments, that the kidney itself takes no part in the process of repair, but that the cicatrix is formed by the evolution of leucocytes migrating from adjoining vessels. Clinical evidence, which is now rapidly accumulating through operations on the kidney, indicates that wounds of the parenchyma will usually heal promptly and without the formation of a urinary fistula, but that the definitive healing of a wound of the pelvis is more likely to be delayed than to fail.

**Symptoms.**—The immediate local symptoms are the presence of a wound of the abdominal or thoracic wall, perhaps large enough and so situated as to permit the recognition of the wound of the kidney by the eye and finger, or having a depth and direction which suggest an injury on anatomical grounds. In exceptional cases the injured kidney protrudes through the wound.

Hæmorrhage, pain, and shock are present in varying degree.

**Hæmorrhage** may be free through the external wound, or the blood may be extravasated amid the loose circumrenal connective tissue, or flow into the abdominal cavity, or down the ureter to the bladder. It is ordinarily slight when only the cortex of the kidney has been wounded. Secondary and late hæmorrhages have been observed.

The escape of the blood through the ureter to the bladder is shown by *hœmaturia*, which may appear promptly or tardily, continue for a longer or shorter time, or be intermittent. Intermittence may coincide with paroxysms of pain, kidney-colic—that is, blood disappears from the urine, and then, after a longer or shorter interval, paroxysmal pains occur, and their cessation coincides with a reappearance of blood in the urine. This sequence of events is explained by the supposition of transient obstruction of the ureter by clots, the paroxysmal pain being excited by the forcing of the clot through to the bladder.

**Pain** may be slight or severe, and so far as it is local it is apparently referable to the general wound rather than to the kidney alone. It is often noted that the pain radiates to the epigastrium, the groin, the testicle, or the thigh. Paroxysmal pain radiating to the testicle and accompanied by the retraction of that organ is distinctly significant of injury to the kidney or ureter, and, as has been stated, is supposed to be provoked by the passage of clots. Vesical tenesmus may be of reflex origin, or may be due to the presence of clots in the bladder.

Urine may escape through the external wound in large or small quantities, but, as a rule, this occurs only when the pelvis of the kidney or the ureter has been opened. If with this opening of the urinary tract coincides plugging of the ureter by a clot, or its retraction after division, all the urine thereafter secreted by the kidney must find its way to the exterior through the wound, or must accumulate in the peritoneal cavity, or in some space made for itself by pushing back the connective tissue surrounding the kidney, and will manifest its presence by corresponding symptoms.

The *general* symptoms are those of ordinary traumatic shock and hæmorrhage, and, as is the case with other injuries also, those belonging to shock do not correspond with the extent of the injury. Some authors attribute the nausea and vomiting, which have been so frequently noted, directly to the kidney and not to the shock, basing their opinion upon the frequency with which the same symptoms accompany other painful affections of that organ.

In two cases of gunshot-wound (Hennen, Demme) a piece of cloth was voided through the urethra, after a lapse of seven months in one of them.

If the patient does not promptly succumb to hæmorrhage or the effects of other injuries, and if uneventful repair does not immediately follow, the *later consequences* appear: suppuration of the wound, perinephritis, pyelitis, general or local nephritis, cystitis, and possibly peritonitis. The extravasation of blood into the surrounding connective tissue favors the extension of such suppurative processes as may be set up in the track of the wound or in the kidney, with the production of more or less extensive perinephritic abscesses, and the septic condition thus established is increased by the decomposition of such urine as escapes into the wound. The resulting abscesses may burrow to a great distance in various directions if a free outlet for the pus is not provided. If the patient survives the immediate dangers of this condition, the cavities contract, and a fistula, which may or may not discharge urine, results. The co-existence of complications is so common that it is not easy to say how much of the admitted gravity of these injuries arises from the wound of the kidney itself. The records of the war of the rebellion contain 26 alleged recoveries from about 70 gunshot cases, but the diagnosis is by no means certain in all of them. Of 50 gunshot cases collected by Edler, 28 recovered; of 20 uncomplicated cases only 5 died; 8 uncomplicated incised wounds gave only 1 death, while of 4 complicated cases all died. In 2 cases the kidney was prolapsed in the wound; both patients recovered.

Post-mortem examinations, made where death had followed after a long interval, or as the result of associated injuries, have shown widely different conditions. In some cases the kidney-wound has been entirely healed; in one with the bullet incapsulated; in others the bleeding had stopped, the wound was filled with a clot, and repair was apparently progressing in the usual way; in others, abscesses have been found in and about the kidney. Sympathetic inflammation of the other kidney has been occasionally noted.

**Treatment.**—In cases that are probably uncomplicated and in which the hæmorrhage is not serious, cases in which the diagnosis of a wound of the kidney rests on the position and direction of the peritoneal wound and on the presence of hæmaturia, the treatment should be that of an incised or gunshot wound of any indifferent region or tissue—namely, cleansing of the surface and of the superficial part of the wound, and an occlusive dressing. But if the flow of blood from the wound is free, or if there is good reason to suspect an important internal hæmorrhage in the perinephritic tissues or the peritoneal cavity, the interference should be prompt and active; the wound should be enlarged sufficiently to give free access to the kidney, so that the extent of its injury may be determined and suitable measures adopted. If the bleeding comes mainly from the parenchyma of the kidney, it can be readily checked by sutures that hold the sides of the wound together; if, on the other hand, it comes from the large vessels near the hilum, they must be secured by ligature, or the kidney must be removed. The narrowness of the space between the twelfth rib and the crest of the ilium, and the depth at which the kidney lies, may make the exploration and search very difficult, and the surgeon should therefore give himself the benefit of free incisions in the most favorable positions and directions (see *Nephrotomy* and *Nephrectomy*); and it may be necessary temporarily to arrest the hæmorrhage by large clamps thrust to the bottom of the wound in order that a suitable exposure and examination of the organ may be made.

If the wound of the kidney should be so extensive that the removal of that organ is necessary, it must be thoroughly exposed and freed from its fatty capsule and the peritonæum, and then the artery isolated and tied, if that is practicable, or the pedicle tied *en masse;* the latter is uncertain and correspondingly dangerous because of the difficulty of drawing the ligature tightly enough to control the vessels; it is safer to use an elastic ligature, or to tie the pedicle in sections.

Plugging of the wound with iodoform gauze, so valuable a means of opposing hæmorrhage in many places, is to be distrusted here, for the bleeding may go on beyond it into the peritoneal cavity, and may also be accompanied thither by urine.

If the pelvis of the kidney is opened into through the cortex, the escape of the urine may usually be prevented by suturing the latter; but if it is directly opened into, provision must be made to carry the escaping urine freely to the surface. The opportunity should be utilized to remove blood-clots from the pelvis and the ureter; the latter can be done by passing a soft catheter or bougie through to the bladder if it will pass, or by directing a stream of water into the ureter to wash the clot out backward.

Prolapse of the injured kidney in a large wound has been observed in a very few cases, and has been given more prominence in some systematic treatises than it appears to deserve. In four cases quoted by Le Dentu, the kidney was removed in two and replaced in two; all the patients recovered. It is taught by some that if the injury is recent and the main vessels not divided the kidney may be replaced, but if several hours have elapsed and infection has probably taken place, it should be removed. The recommendation of removal is based upon the assumed probability of setting up a dangerous septic process in the perinephritic tissues by the return of an organ presumably covered with infectious microbes; but the argument is purely theoretical, and there seems to be sufficient ground to maintain that the risks could be reduced by antiseptics, iodoform packing, and drainage to such a degree that they would not outweigh the advantages of retaining the organ. Of course, if the vitality of the kidney has been seriously compromised by division of its main vessels, or if it has been so extensively lacerated that there is but little probability that it would be able to perform its functions if it were saved, the prudent treatment would be immediately to remove it.

The treatment of uncomplicated gunshot-wounds is guided by the same principles as that of incised wounds; in complicated cases the character of the complication will probably dominate the treatment.

The inflammatory and suppurative conditions which arise in consequence of a wound of the kidney will be considered in another section; it is sufficient here to say that the treatment is to be conducted according to the principles governing the treatment of similar conditions in other regions: free evacuating incisions and drainage, the removal of foreign bodies and necrotic tissue, and possibly an ultimate nephrotomy, as the most expeditious and effectual means of bringing to an end processes that are endangering the life of the patient.

## SUBCUTANEOUS LACERATIONS AND RUPTURES.

The statistics above quoted show that these are much more frequent than open wounds of the kidney, and doubtless this numerical superiority would be considerably increased if the statistics should include the due proportion of the slighter cases.

The injury appears to be caused much more frequently by direct than by indirect violence, fifty-six and thirty cases respectively, according to Edler. The common direct cause is a fall from a height. Some authors describe as laceration of the kidney by indirect violence those not uncommon cases in which transient hæmaturia follows violent contraction of the abdominal muscles or prolonged exercise on horseback; but others—more plausibly, I think—class them as cases of lithiasis, and attribute the bleeding to injury of the somewhat congested mucosa of the pelvis of the kidney by small uric-acid crystals or actual gravel. It is, however, to be remembered that such muscular efforts appear to be a cause of perinephritic abscess. Among the direct causes are blows, kicks, crushings between moving bodies, the passage of the wheel of a wagon, a fall against some prominent object, like the corner or the edge of a table. Simon noted in his first nephrectomy that the handling of the kidney in the course of the operation caused several subcapsular hæmorrhages; and Maas has shown experimentally that notable laceration can be effected by the pressure of the fingers.

The injury may vary in extent from slight subcapsular hæmorrhage to complete rupture of the organ. Apparently the cortex is involved in all cases, but its laceration may or may not extend to the medullary portion. Extensive lacerations are commonly transverse. A case of complete longitudinal rupture caused by the passage of a wagon-wheel occurred during the war of the rebellion, and is reported in Circular No. 3, 1871, S. G. O., page 106, and Edler notes two others. The superficial and slighter lacerations vary indefinitely in direction and extent. The surface of the rupture may be almost as regular as that of an incised wound, or it may be irregular and pulpy. The anterior and posterior surfaces are torn with equal frequency (Edler). Of Morris's twelve cases, seven were partial ruptures, extending through half the thickness or less of the organ; two were complete divisions; in one the entire kidney was crushed to pulp; in one there was only subcapsular hæmorrhage; and in one there was blood in the pelvis, but no injury of the kidney substance could be detected.

The mechanism of the laceration is not always clear. Transverse rupture in a fall from a height has been attributed to the momentum of the less firmly attached lower portion (Le Dentu), or to the forcible bending of the trunk when the body strikes the ground (Morris). Rupture of the anterior portion has been explained on the theory of forcible dorsal flexion of the trunk in which the kidney is stretched across the twelfth rib, and rupture of the posterior portion on the theory of direct pressure of the kidney against and past the ribs.

The peritonæum covering the kidney appears to be but rarely torn; more frequently, it is claimed, in the young than in the old.

Hæmorrhage may be entirely within the substance of the kidney, or it may be confined within the fatty envelope, sometimes pressing it back and forming a large hæmatoma; or this envelope may itself be torn, and the blood pass far and wide along the intermuscular planes, in the retroperitoneal tissue, or into the peritoneal cavity. Blood that gets into the pelvis, either directly from the torn parenchyma or through a rent in its own wall, may pass to the bladder or may clot and obstruct the ureter. Morris alleges that such obstruction can produce permanent structural occlusion of the ureter.

Associated injuries are frequent, and, indeed, are almost constant in the severer cases. Among them may be mentioned rupture of other viscera—liver, spleen, ureter—contusion or rupture of the intestines, fracture of the ribs.

A very striking and important complication or consequence has been noted in two cases by Poland and Moxon (Guy's Hospital Reports, Third Series, vol. xiv), namely, complete thrombosis of the renal vessels.

If the individual survives the immediate consequences of the injury, the wound of the kidney may undergo complete repair, or suppurative and degenerative processes may ensue and again place life in danger. It has been satisfactorily demonstrated, both clinically and experimentally, that a laceration of the kidney may heal, leaving a more or less well-marked scar. Cases have been reported in which the examination has been made at dates varying from a week to five years after the accident, and has shown either complete cicatrization, or the process so far advanced that complete repair would probably have taken place if the patient had survived the associated injuries.

Maas has traced the process in detail by the aid of experiments upon animals. He found the cicatrix retracted and the surface correspondingly depressed, and fine prolongations running from it into the adjoining healthy tissue of the kidney, scattered through which were many small cysts, some of which apparently were the remains of collections of blood, while others were dilated canaliculi. In another series of experiments he found as occasional results atrophy of the kidney, its complete disappearance by the formation of a large, irregular hæmorrhagic cyst, and hydronephrosis. Mounier, quoted by Maas, reported a case in which the autopsy, forty-one days after the accident, showed a blood-cyst weighing seven and a half pounds, extending from the sixth rib to the crest of the ilium, covered by peritonæum, and with a very irregular deeply grooved wall which contained kidney tissue at only one point. Maas attributes the disappearance of the substance of the kidney to thrombus of the renal vessels.

Other late consequences are suppuration in or about the kidney, interference with the secretion or the voiding of urine, nephritis, and the formation of stone. They will be considered under another head.

**Symptoms.**—Except for these immediate local symptoms which pertain to the external wound, the symptoms of subcutaneous injury are the same as those of open wounds of the kidney. There are the same general symptoms, varying in severity in the different cases—nausea, vomiting, shock, and perhaps the constitutional signs of severe internal hæmorrhage.

The following history is an illustration of the symptoms and course in the milder cases (Notta, Schmidt's Jahrbuch, 1859, No. 10, p. 90, quoted by Edler):

"A powerful peasant, forty-eight years old, was kicked by a horse in the right side. He fell to the ground and was unable to rise; great pain at the seat of injury. Three hours later Notta found him in bed, on his back, pale face, cool surface, pulse 70; constant complaint of frightful pain in right side. No trace of the blow on the surface. It had been received upon the lower ribs, which, however, were not broken, although they and the entire side were extraordinarily tender on the slightest pressure. The abdomen was soft, and not distended; percussion-note clear everywhere. No nausea, vomiting, or chills. The patient frequently voided, with great pain, pure blood through the urethra. The next day the pain continued; the urine was dark, and contained a considerable amount of blood, but no clots. Urination was more frequent than normal; the bladder was emptied. The pains increased in severity; the patient was hardly able to breathe, and felt very weak. On the third day the pains diminished. The urine, which was passed without pain, was turbid, orange-colored, and contained blood. On the fifth day kidney-pains were renewed. The urine grew clearer. An ecchymosis four to five centimetres in diameter appeared two centimetres above the anterior superior spine. On the eleventh day the urine was clear. A fortnight later the man returned to work, but he long remained sensitive to deep pressure in the region of the kidney."

Pain, usually severe at first, may be modified by the injuries of adjoining parts. The characteristic radiation to the groin and testicle, with retraction of the latter, is, as we have seen, commonly to be referred to the passage of clots of blood through the ureter. These paroxysms, though common, are not constant; they may be intermittent, and sometimes do not appear until after several days.

The appearance of an ecchymosis in the loin, or in front below the ribs, can have no special significance in cases of injury by direct violence; but an ecchymosis in the region of the external inguinal ring has been deemed pathognomonic of injury of the kidney. It has been observed in several cases, in one of which (Letulle, Bull. de la Soc. Anat., 1876, p. 236) the autopsy verified the diagnosis, and proved the connection; the blood had made its way alongside the spermatic vessels to the scrotum.

**Hæmaturia** is a common and valuable sign. It has been absent in some cases of extensive laceration because of the plugging of the ureter by a clot; and in other cases of assumed injury its absence has been explained on the supposition that the lesion was only a slight laceration of the cortex. Ordinarily it appears promptly, but in four of the cases collected by Edler it appeared first on the third, seventh, ninth, and fourteenth days respectively. It may continue for a few hours only, or for days, weeks, and even months, and may vary in degree from moderate staining of the urine to almost pure blood. Le Dentu says that even when the blood flows into the bladder in large quantities—several quarts—it rarely clots there, so that retention of urine due to this cause is very exceptional. The voided clots are sometimes long and cylindrical, apparently having been formed in the ureter. In some cases the urine remains albuminous for several days after the blood has ceased to be present in it. This may be due to the admixture with the urine of the serum of a clot that has formed in or in communication with the pelvis of the kidney; in other cases it has been the first symptom of a commencing chronic nephritis.

Urination may be frequent and urgent because of unexplained reflexes, as observed in connection with injuries of other parts, or because of reflexes originating in the kidney, or because of clots in the bladder. Occasionally there is complete suppression of urine, as when both kidneys have been torn, or when there has been only one kidney; more frequently the amount of urine has been only diminished, the diminution lasting for several days; exceptionally the amount has been increased.

The later symptoms have their rise in the later processes and changes that have been already mentioned. If suppuration takes place in and about the kidney, not only do the usual constitutional symptoms of that process appear, but the urine also may contain pus, and the abscess may become large enough to be recognized by palpation. Pus in the urine may also have its origin in a cystitis set up by the presence of blood in the bladder or by catheterization.

An extensive and persistent hæmorrhage may show itself in ecchymosis in the loin or in the anterior abdominal wall and scrotum, as already mentioned, or as a collection of blood within the fatty capsule or within the kidney itself (hæmatonephrosis), or, rarely, deep in the pelvis behind the peritonæum, within the peritoneal cavity. Such a hæmatoma forms slowly, and is recognized as an elastic globular mass in the loin or hypochondrium; it is much more frequent as a perinephritic hæmatoma than as a hæmatonephrosis.

A similar elastic globular swelling is exceptionally formed by urine, mingled perhaps with blood, that continues to be secreted by the kidney and is prevented from reaching the bladder by obstruction or rupture of the ureter. There is good reason to think that such urinary collections are extrarenal, the urine escaping into the circumrenal tissue through a rent in the pelvis; and that when such escape is impossible, the kidney ceases to secrete before any considerable amount of urine has collected within the pelvis, so that a notable distention of the pelvis by simple pressure of urine retained within it is very rare, or perhaps has never occurred.

**Diagnosis.**—For the diagnosis of rupture or laceration of the kidney the most trustworthy symptoms are hæmaturia and pain radiating to the testicle; but neither is pathognomonic, nor is its absence proof that the injury has not been received. As has been stated, blood may appear in the urine after a traumatism, or after a violent muscular effort which, there is good reason to suppose, has not injured the kidney; but such cases appear to be very rare, and to be associated with a history of chronic irritation or congestion of the upper urinary passages. On the other hand, the absence of hæmaturia does not exclude certain mild lesions limited to the cortex of the kidney, or severe ones associated with rupture or plugging of the ureter. Local tenderness on pressure is significant only when it is clearly not due to contusion of the abdominal wall, and ecchymosis is significant only when it is tardy and appears at a distance, at points that are in ready communication along connective-tissue planes with the site of the kidney.

**Prognosis.**—The prognosis, so far as it is shown by the percentages of published cases, is grave. Of Edler's 90 cases, 45 died; of these, 33 were classed as "complicated" cases, with 25 deaths (75 per cent); 17 patients died within the first two days; 19 died of hæmorrhage, 14 primary, 5 secondary; 5 of peritonitis, 5 by the immediate effects and extent of the crushing, 3 by the wound of both (1), or the absence of a second kidney (2), 3 by suppurative processes, and, by various complications. Excluding the cases of early death by bleeding, severity of the injury, and complications, there remain 61 cases, with 13 deaths (21 per cent), from which Edler draws the conclusion that, if a subcutaneous injury is not so severe as to cause death within two or three days, the prognosis is more favorable than after injury of the liver or spleen. Maas's statistics indicate an especial gravity in children under ten years of age, 6 deaths in 7 cases. As has been already intimated, these statistics doubtless do not contain a due proportion of the milder cases.

**Treatment.**—The first indications, in any case of recognized or suspected injury of the kidney, are to relieve the shock and pain and to arrest such hæmorrhage as may be going on. These are met by absolute rest in bed, the administration of sedatives and anodynes, the avoidance of stimulants except so far as they are clearly indicated on special grounds, and methodical compression of the abdomen, and the internal administration of hæmostatics if it appears that the bleeding is free and persistent. Compression can be made by the usual abdominal binder over a thick layer of cotton or by a sheet of adhesive plaster extending from the middle of the back around the injured side and well across the front of the abdomen. Morris strongly recommends half-drachm doses of the liquid extract of ergot every three hours as "the most certain and rapidly efficacious remedy of this sort." The food should be limited in quantity, and concentrated, in order that movements of the bowels may not be frequent. Vomiting must be immediately checked, lest it provoke a recurrence of the bleeding. Morris attributes a recurrence in one case to the "passage of hardened fecal matter along the colon and thus across the surface of the kidney," and in consequence advises that the bowels should be relieved only by enemata, or left undisturbed for several days. It seems not unlikely that this recurrence, and a few others attributed to changes in diet, may have been simple coincidences. The external application of ice or the cold-water coil is routine treatment to check hæmorrhage, but it can hardly be supposed that the temperature of the deeper parts is thereby lowered sufficiently to have any effect.

A very serious question—Is nephrectomy indicated?—occasionally arises when the signs of internal hæmorrhage steadily increase and indicate imminent danger to life, notwithstanding the use of such measures as have been mentioned. The only practicable operative method of arresting the bleeding is by nephrectomy, for there can be no thought of seeking and securing a single vessel under such circumstances. Whatever is to be done for the exsanguinated patient must be done rapidly and with the least possible draft upon his strength. The operation has been done in a few cases (Newman has collected five, with three deaths), and seems to be fully justified when the condition is clear; but it must be remembered that it is a vastly more dangerous operation than the ligature of even a large artery in continuity, and that it is not to be resorted to so promptly as the latter in cases of persistent or secondary hæmorrhage from some arterial branch in a limb.

The early symptoms which may suggest the propriety of a resort to nephrotomy are those of serious internal hæmorrhage, pallor, sighing respiration, restlessness, and a small, rapid pulse, possibly associated with the frequent voiding of blood from the bladder, or with the formation of a more or less tense, fluctuating swelling in the loin. The best judgment of the surgeon will be required to determine the propriety of operative interference and the time at which it shall take place; for, on the one hand, it may be urgently necessary that bleeding should be promptly arrested, and, on the other, each day's increment of incapsulation of the escaped blood and consolidation of the surrounding tissues adds to the chance of successful interference.

Occasionally the flow of blood into the bladder is so profuse as to create special indications for treatment, for the clots interfere with the voiding of the urine, and at the same time add to the vesical irritability and tenesmus. The catheter does not relieve, for the clots obstruct it, and the distention that results from the accumulation of blood and urine causes severe and constant pain, and introduces new elements of danger—possible rupture of the bladder, or the setting up of a cystitis which may spread to and incapacitate the remaining uninjured kidney. It has been suggested to relieve by breaking up the clot with a lithotrite, or by washing it out with a Bigelow evacuator, or by disintegrating it with injections of a two-per-cent solution of gallic acid; but it seems probable, in the absence of demonstrative clinical experience, that if the well-proved method of reliance upon the solvent action of the urine should seem too hazardous, it would be better to resort to cystotomy, either perineal or suprapubic. Rawdon (Lancet, May 26, 1882, p. 907) reported a case in which cystitis supervened upon recurrent hæmaturia, and he performed lumbar nephrectomy on the seventeenth day; the cystitis persisting, he did lateral perineal cystotomy four days later and evacuated fetid clots; but the patient died on the fourteenth day, of pyelo-nephritis of the other kidney, which had apparently been excited by extension upward of inflammation set up in the bladder by the retention and the decomposition of the clots.

It is easy to draw the inference that in this case the interference was unduly delayed, and that if it had been undertaken earlier the patient might have been saved; and it is also easy to lay down the principle that nephrectomy is indicated when without it the patient will die of hæmorrhage, and that cystotomy is indicated when without it a dangerous cystitis and pyelonephritis will ensue; but it is far from easy in any given case to say that the indications are sufficient to call for the operation. Fortunately, the cases in which the questions will arise are very infrequent.

Later in the course of a case suppuration of a hæmatoma within or about a kidney, or the formation of a urinary cyst, may call for operation. Suppuration requires a free incision in the lumbar region, with the precautions and after-treatment appropriate to the conditions; in some cases nephrectomy, either as a primary or secondary operation, has been done. Hydronephrosis may be temporarily relieved by tapping, with the chance that recurrence may not take place or may be so slow that more radical and dangerous measures will be unnecessary. These various conditions will be considered in detail in another chapter.

## II. NEPHROLITHIASIS—GRAVEL—KIDNEY STONE.

The scope and character of this work will not permit detailed study of the cause and of the constitutional treatment of the conditions indicated by the titles of this section; for them the reader is referred to works on internal medicine, to which branch of medical science these conditions long belonged wholly because of the powerlessness of the surgical art to aid in them. To that powerlessness has succeeded within the last twenty years a notable and increasing efficiency, and the surgeon is called upon to relieve not only those conditions which constitute the later and extreme stages for which the need of an efficient surgery was always recognized, but often also certain slight and earlier ones which were looked upon as purely medical affections.

Under nephrolithiasis—a term which etymologically signifies the presence of calculi in the kidney—we here include the various stages of the local manifestations of the general constitutional condition that underlies most of them, and those other affections in which similar manifestations are of purely local origin. We have to deal not only with those classes of cases in which the stone remains lodged in the kidney and is of considerable size, but also with those others in which the stones are numerous and small, perhaps barely recognizable by the unaided eye, and are voided with the urine, and with those in which the patient presents many of the symptoms associated with the other forms, but whose kidney is free from stone, and whose urine is free from crystals—cases of simple nephralgia, but still cases in which the same constitutional condition is involved, and which can be surgically relieved.

Nephrolithiasis is observed at all ages, even during intra-uterine life.

According to Morris, it is most common before the age of fifteen years and after that of fifty, the youthful patients belonging usually to the poorer classes, the older to the richer. It is more prevalent in some countries—England, for example—than in others, and the difference is apparently due to climatic and dietary conditions. It is often inherited, and in its uric-acid form is clearly associated with the gouty diathesis.

The concretions, the different sizes of which are rather arbitrarily classified as calculi, or stones, gravel, sand, and crystals, are found in the pelvis, infundibula, or calices, or in dilated tubules or abnormal cavities in the substance proper of the kidney. In the bodies of still-born children and of those that have lived for only a few hours, and in the contracted kidney of gouty adults, it is not uncommon to find collections and even small concretions of crystals of uric acid or urates in the collecting tubules of the pyramids and the straight tubules of the cortex. Occasionally, but very rarely, kidneys are found that contain, within completely closed cavities in the parenchyma, gravel and even calculi of considerable size; these are interpreted as later results of the lodgment of crystals or minute concretions within the tubules, the crystals having increased in size by the continuous precipitation upon them of the urinary salts, until finally, by pressure and the resultant irritative changes a closed cavity with fibrous walls had formed about them.

By far the most frequent seat is, however, in the pelvis or one of its prolongations, an infundibulum or calix, and the concretions found in this situation are ordinarily of considerable size, for the smaller ones are likely to escape through the ureter. If the calculi are small they may be very numerous, and even if quite large there may be two or more of them, the pelvis being correspondingly dilated and the parenchyma thinned. Ordinarily there is but one stone of any considerable size, and in only one kidney, but exceptional cases showing many variations have been reported: for example, one in which each kidney was like a bag full of small stones; another in which there were 100 stones in one kidney and 70 in the other; another in which there were 36 stones in one kidney and 6 large ones in the bladder; and others in which each kidney has contained one or more very large stones. The largest that have been reported are (Revue des Sc. Méd., 1875, vol. v, p. 499) one weighing 1,015 grammes, and accompanied by 60 grammes of small ones; and one, reported by Pohl (De prost. calcul. Quoted by Le Dentu), weighing five pounds.

The shape may be regularly rounded and the surface smooth, or the calculus may closely resemble in shape and surface a branch of coral with a central body and several prolongations corresponding to the calices within which the increase in size has taken place by continuous deposition (Fig. 2). In a few cases a prolongation has grown down into the ureter from a large calculus occupying the pelvis (Fig. 3). The irregularity in shape and the roughness of the surface may be such that the stone can not be detached without extensive laceration of the kidney.

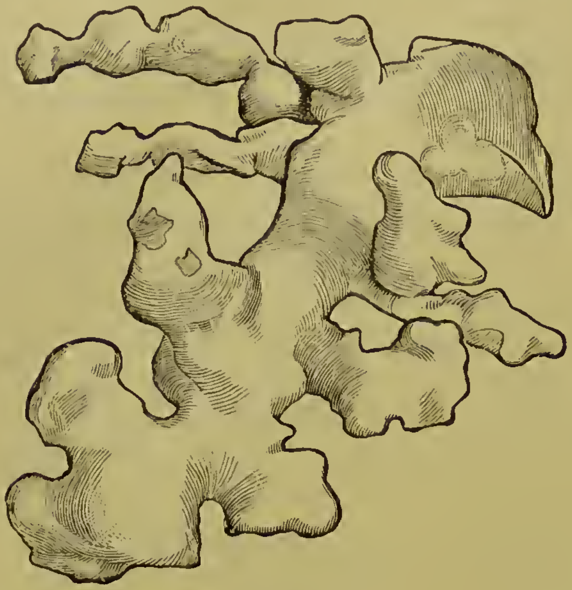

Fig. 2. (Keyes.)

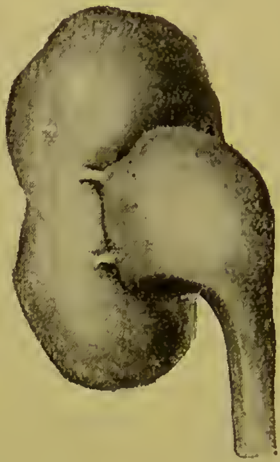

Fig. 3.—Calculus extending into the ureter. (Torres.)

**Chemical Composition.**—According to Morris, the most common form of renal calculus is the uric acid; the next is oxalate of lime. These constitute the "acid" variety of the French, in contradistinction to the less common "alkaline," the phosphatic, carbonic, and the ammonio-magnesian. The urates, of ammonia or mixed, are infrequent; and calculi composed of cystine or of xanthine are very rare. The composition of a calculus may be uniform or mixed; there may be alternating layers of the different constituents, or there may be a central nucleus of one kind with a different homogeneous or a stratified covering. The nucleus, or the central portion of uric acid or oxalate, will often be coated with one or more phosphatic layers whose formation is the result of the catarrhal or ulcerative condition excited by the presence of the original stone. The nucleus may be some indifferent, non-crystallizable body, such as a small blood-clot, piece of fibrin, or fragment of a tumor.

Morris quotes Mr. Thomas Taylor, who analyzed the calculi in the Hunterian Museum, as saying that the nucleus of renal calculi formed in infancy is urate of ammonia, while that of calculi formed in young adult life is uric acid, and that of calculi formed after the age of forty years is oxalate of lime.

Uric-acid stones are usually smooth and of a yellowish or reddish color; those of oxalate of lime have a very irregular surface (the mulberry calculus), and are brown or reddish-brown; those of earthy phosphates are gray and friable. The color of any of them may be wholly changed by staining with blood.

Simon says that he found uric-acid calculi in one kidney and phosphatic concretions in the other, and explains what he calls the very striking and heretofore unobserved condition as the consequence of a sympathetic inflammation after suppuration of a calculous kidney. It is worthy of note, that of ten cases of stone in the kidney which came under his observation both kidneys were affected in three.

As the result of the irritation excited by the presence of the stone, and in other cases of the more or less complete obstruction of the flow of urine, the kidney undergoes certain pathological changes. The grosser forms—pyelitis, pyelonephritis, perinephritis, and hydronephrosis—will be subsequently considered in chapters devoted exclusively to them, and we shall here treat only of changes which may or may not eventuate in one of those just mentioned; changes in the kidney substance excited by inflammation or by intermittent retention.

The effects of inflammation due to the presence of a calculus in the cases in which it remains below the grade of suppuration are seen in changes in the pelvis—thickening of its wall and changes of its epithelium—which are relatively of slight importance, and in a notable increase in the amount of the connective tissue of the parenchyma, and in the effect upon the tubules and their epithelium produced by the retraction of this new tissue—that is, the granular fatty degeneration of the epithelium and its disappearance in many places, and the flattening and obiteration of the tubules and their occasional dilatation by retention. When the pyelitis is suppurative the inflammatory reaction in the parenchyma may be more intense, and small abscesses may form within it here and there. The ultimate result of this destruction of the glandular tissue may be an atrophy of the kidney as a whole, with thinning and hardening of the cortex, or the organ may be notably increased in size by the dilatation of the pelvis and of the accidental cysts formed within it, the diminished cortex being stretched out into a thin shell. Such stretching of the cortex under the pressure of urine retained within the pelvis by a calculus that blocks the ureter, or of steadily enlarging cysts, is of itself a factor in the destruction of the

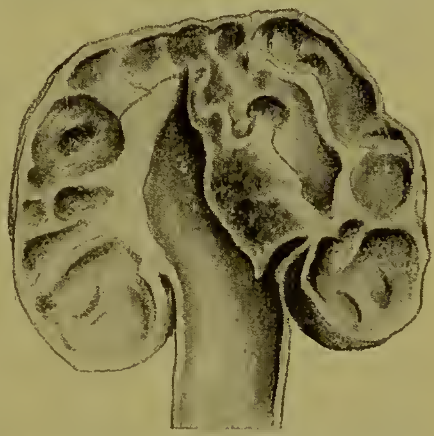

Fig. 4.—Kidney disorganized and converted into multiple pouches containing calculi; considerable dilatation of ureter. (Torres.)

parenchyma, and it is thought that the extreme conditions of atrophy sometimes observed, those in which the kidney is reduced to a small nodule with barely a trace of glandular tissue, are to be explained on the theory of primary dilatation followed by the escape of the liquid contents and retraction of the wall.

Modifications in the shape of the kidney correspond, in general terms, to the size of the calculus, if the latter is large, and to the presence or absence of dilatation. On section the cut surface shows a more uniform appearance than is normal, and is sometimes studded with minute cysts. The large cysts seen on section are usually portions of the calices that have been crossed by the knife, but some of them are actual closed cysts formed within the parenchyma. They sometimes contain concretions.

The question of the effect of the destruction, removal, or incapacitation of one kidney upon its fellow, which was suggested by Rayer and first studied by Simon, has not yet been completely answered. It is known that in many cases the remaining kidney has satisfactorily performed the double duty that has been thrown upon it, and that it has apparently undergone a notable increase in size. In other cases, perhaps equally numerous, the remaining kidney has shown more or less marked evidences of disease, and after abstraction of those cases in which the changes were probably independent of the disability of the other kidney, and were the result of a general cause or of an inflammation ascending from the bladder, there still remain a few cases which have seemed to some observers to justify the theory of reflex nephritis.

**Etiology.**—The underlying, primary cause of the formation of gravel or of a calculus in the kidney is, in the great majority of cases, a general, perhaps even a constitutional one, and only in a relatively small minority is the cause local. A local cause, which has been clearly established by the study of the formation of vesical calculus, is the existence of a catarrhal or ulcerative condition of the mucosa of the pelvis and its prolongations, the products of which combining with some of the constituents of the urine provoke the precipitation of the phosphatic salts, and thus either originate a phosphatic calculus, or lead to the rapid deposition of a phosphatic layer upon a pre-existing calculus of uric acid or oxalate of lime.

The causes and processes which lead to the much more frequent crystallization of uric acid, urates, oxalate of lime, and the hard phosphates are by no means so clear. In respect to uric acid, it is known to coincide with a diathetic condition (gout) and with certain dietary and hygienic peculiarities which coexist with and apparently have a causal relation to an excess of uric acid in the urine; and to this excess crystallization within the urinary reservoirs and passages is presumably due, although the immediate cause or provocation thereof is not known.

In like manner crystallization of oxalate of lime is thought to follow an excess of that constituent in the urine; that excess also is thought to be a manifestation of the uric-acid diathesis, and oxalic acid, like uric acid, is thought to be an irregular product of the normal metabolism. It is of course well known that oxaluria is not dependent upon the ingestion of food containing large amounts of oxalates, but that it habitually coincides with a nervous and depressed condition in sedentary, overfed, gouty individuals.

If cystine is a derivative of uric acid, as is now believed, the formation of calculi composed of it should be referred to the same causes.

An excess of phosphates, sufficient to make the urine alkaline, habitually exists during digestion, and may be constant for hours or days in those who are anxious and overworked, or whose food favors the presence of these salts in the urine.

One immediate cause of crystallization may be accepted as proved, namely, the presence in the liquid of some solid body, no matter how minute, such as a clot of blood, a shred of mucus or of fibrin, a fragment of tissue. It provokes the precipitation upon it of the salts held in solution, and if it is so situated as not to be carried away by the flow of urine it becomes the nucleus of a calculus. Many such cases have been reported; many calculi when sawn in two have shown a small central cavity containing the remains of a blood-clot or of mucus; others have formed about a fragment of a tumor of the kidney or of a hydatid cyst; and in one singular case, quoted by Le Dentu, a fragment of the carious second lumbar vertebra had been detached, and had made its way by ulceration into the kidney, and had there become covered by a complete shell of urinary salts.

To say that a tendency to gravel or kidney-stone can be inherited, is only to say that a child can inherit the constitution of which these are a manifestation.

Statistics that have been collected to show the relative frequency at different ages, can at the best give only approximate results, for many kidney-stones grow so slowly and give rise to so little disturbance that they may be borne for years without their presence being suspected. The opinion of Morris upon this point has already been quoted; to it may be added the statistics concerning gravel collected by Durand-Fardel, 280 patients from well-to-do classes:

Under 20 years of age, three cases; from 20 to 29, nine cases; from 30 to 39, forty cases; from 40 to 49, thirty-eight cases; from 50 to 59, seventy-one cases; from 60 to 69, seventeen cases; from 70 to 79, twelve cases.

Finally, it is much more frequent in men than in women, and in those who lead a sedentary life and are overfed. The influence of certain foods and drinks is occasionally very marked, and there are individuals who can not drink a single glass of Burgundy without having a sharp attack of nephralgia, or perhaps even a paroxysm of kidney-colic.

**Symptoms.**—To describe in detail the widely different forms under which nephrolithiasis may present itself would require much space and much repetition, and it seems best, therefore, separately to describe the signs and symptoms, and then briefly to indicate the ways in which they may be grouped.

**Pain.**—A dull, aching pain deeply situated in the small of the back and flank, often unilateral, sometimes radiating along the ureter and into the testicle or the thigh, usually increased by exertion or local pressure, is habitual in irritative or congestive states of the kidney, and is what is commonly indicated by the term nephralgia. It may coincide with any grade of nephrolithiasis, from that of over-acid urine with a few crystals to that of large calculi with at least partial preservation of the structure and function of the kidney.

Not only may pain radiate to the kidney and thigh, but it may persist in these regions after it has disappeared from the loin, and, exceptionally, it may appear there while the loin remains free; at least, in a number of reported cases patients whose kidneys have subsequently been found to contain calculi, or who have shortly thereafter passed gravel, have complained of sciatica or of a sharp aching or burning pain in the thigh, calf of the leg, and foot, and the pain has been attributed by those who have reported or quoted the cases to the changes in or the irritation of the kidney. The pain in the testicle has occasionally been accompanied by all the signs of epididymitis.

Instead of a dull ache, the pain in the region of the kidney may be sharp and severe, with remissions or intermittences, or with very sharp exacerbations; and the condition of the patients who are thus afflicted presents all grades of severity between a few rare paroxysms at long intervals and a pain that is almost continuous and so violent that men have committed suicide to end it, and women have aborted because of it. In severer cases opium is not sufficient to relieve, and we must resort to chloroform.

To this paroxysmal form, especially when the intervals are completely free from pain, the term *kidney-colic* or *renal colic* is especially applied, and some seek even to restrict the term to those cases in which the maximum of pain shifts its seat along the ureter during the paroxysm, and the other signs point clearly to the passage of a stone or other solid substance through this tube. A paroxysm may begin abruptly without the slightest warning, or it may be preceded by dull lumbar pain, or sometimes by symptoms which apparently have no connection with the urinary passages, but which the patients soon learn to recognize as a warning of an impending attack. Thus, in one of Le Dentu's patients, a persistent inclination to go to stool habitually preceded a paroxysm for several hours. The paroxysm lasts for a few hours, rarely a day, and usually ends abruptly, and this abrupt termination is thought in most cases to mark the final escape of the calculus from the ureter into the bladder or back into the pelvis.

There is every reason to accept the explanation as correct in those cases in which the paroxysm occurs only once or at long intervals, and is promptly followed by the escape of the calculus through the urethra; but it is not so easy to explain the paroxysmal pain in those cases in which the autopsy or an operation shows a large stone firmly adherent to the wall, or immovably fixed by its many irregularities in an infundibulum or calix, or a large stone lodged in a dilated ureter. The character of the pain suggests that it is excited by the contractions of the muscular wall of the cavity within which it lies, and its cessation would then coincide, in the case of a fixed stone, with the arrest of these contractions. On the other hand, quite a number of cases have been reported of late years which indicate that typical paroxysms may occur without the presence of a stone or any other solid or semi-solid object in the kidney or ureter, and that consequently it is possible that spasmodic contraction of the ureter or pelvis may be sufficient to cause the pain. Such cases are those in which, after several paroxysms not followed by the voiding of a stone, the kidney has been exposed by incision and has been explored by palpation and by puncture with the needle at many points without disclosing a stone, and this exploration has been followed by the permanent cessation of the paroxysms. In one of my own cases in which this sequence of events took place, the operation was preceded by an experience which at the time I deemed demonstrative of the presence of a stone in the pelvis. I had caused the patient to be inverted for a moment during a paroxysm, and the pain had instantly ceased. On its recurrence a few days later I operated; the exposure of the kidney to sight and touch was exceptionally good, and I felt that there was no calculus in the pelvis; the latter was small, and showed rhythmical contractions, about thirty per minute, that continued down the ureter; the latter had a sharp turn in its upper portion. The young man remained under observation for a year without recurrence. A plausible explanation of the curative effect of these exploratory incisions down to the kidney has been recently offered in the supposition that the pain is due to temporary distention of the pelvis by urine, the ureter having been temporarily bent upon itself by a slight displacement of the kidney. The cicatrix left by the operation fixes the kidney and prevents recurrence. (See Intermitting Hydronephrosis.)

Pressure upon the kidney through the abdominal wall from in front or behind may reveal tenderness; it can be made with the patient in dorsal decubitus, or lying on the opposite side on a round cushion so placed under the loin as to keep the spine straight, or even give it an upward lateral convexity.

Special excitants of the pain are occasionally found in the more violent forms of exercise and errors in diet.

**Nausea** and **vomiting** habitually accompany the paroxysms and are probably the result of the pain. Whether or not there is any more direct connection by nerve-reflex between the pelvis or ureter and the gastro-intestinal nerve-center which would enable irritation or congestion of the former to excite anorexia, nausea, or vomiting, has not been established. Some authors—Torres, Morris—believe there is, and claim that these symptoms are very common at times when the pain is not severe, and under circumstances that make such a causal relation the most plausible explanation.

**The urine**, in cases of simple nephralgia and of gravel without severe pain and other obstructive symptoms, is rather scanty, high-colored, and over-acid. The "alkaline tide," which normally should appear two or three hours after a meal, is absent, and the urine if left to stand will promptly show a bluish line at the edge, and deposit the dark-reddish crystals of uric acid along the sides and at the bottom of the vase. The microscope may reveal, in addition, crystals of oxalate of lime, a few red blood-corpuscles, and possibly epithelial cells that can be recognized as belonging to the pelvis or ureter. (Under the much rarer circumstances of *primary* phosphatic gravel the urine is alkaline and shows an excess of phosphates. The *secondary* phosphatic gravel is merely an incident of pyelitis.)

Small stones may be voided with the urine without the knowledge of the patient; the larger ones are usually heard to strike against the side of the chamber, or are passed through the urethra slowly and with pain. Occasionally they lodge in the urethra and have to be removed by the surgeon, or they remain in the bladder and become the nucleus of a vesical calculus. Incredible stories are told of the great size of calculi that have been spontaneously passed per urethram; the largest of which I have seen mention was one said to have been in the museum at Strasburg, which measured ten centimetres in circumference, or about one and a quarter inch in diameter. Le Dentu reports a case in which he removed on one occasion seven calculi from the urethra of a man who had just passed seven others spontaneously. Le Dentu found the eighth lodged in the fossa navicularis, and the remaining six in the urethra behind. After enlarging the meatus the stones were easily pushed forward and out. The largest measured fifteen millimetres in diameter, corresponding to No. 46 of the French urethral scale.

The intermittent appearance of a moderate amount of **blood** in the urine is a constant symptom of a stone that is lodged in the kidney. In fact, the appearance of a small amount of blood, after such exercise as a ride on horseback or over a rough road in a wagon, in urine that is at other times free from it, is deemed almost pathognomonic of a stone in the pelvis of the kidney. Again, it may be present in quantities sufficient distinctly to color the urine, or even to give it the appearance of being almost pure blood. Long, cylindrical clots of blood are generally thought to have been formed in and to take their shape from the ureter. The source of the bleeding in the slighter cases is probably some slight lesion of the congested mucosa by a passing crystal or small stone; in the more severe cases it appears to come from the vessels of an ulcerated surface.

**Mucus** and **pus,** when present in notable quantities, and of kidney origin, are incidents of pyelitis, and are symptoms of nephrolithiasis only so far as the pyelitis is a result of it.

**Frequency and urgency of micturition,** well-known consequences of renal irritation, are naturally found among the transitory and permanent symptoms of nephrolithiasis. This symptom so commonly has its origin in the bladder that it is very easy to overlook the rarer renal cause unless the physician keeps the possibility in mind. Finally, palpation of the kidney may show its enlargement, or may cause recognizable grating of one stone upon another.

**Diminution** or **total suppression** of the urine, lasting for a few hours, has been observed, and is attributed to reflex action upon the vaso-motor nerves of both kidneys even when the calculus is unilateral. In the cases in which it lasts a much longer time it must be attributed to the simultaneous obstruction of both ureters, or to obstruction of one ureter when the other kidney is congenitally absent or has been incapacitated or destroyed by disease. The occurrence is extremely rare. It may follow a well-marked attack of nephralgia or kidney-colic, or may begin insidiously and attract no attention until the symptoms of uræmia set in. The amount of urine passed from day to day may show notable variations, and at times may even be in excess of the normal in consequence of the temporary removal of the obstruction. It differs from the high-colored, scanty urine of partial suppression, and is pale, clear, and of low specific gravity. As time passes the local signs of hydronephrosis may appear, to be followed by œdema of the limbs and uræmia. The average duration of life is said to be from ten to fifteen days. In about one fifth of the cases recovery takes place by spontaneous removal of the obstruction, occasionally by its passage through the ureter.

The grouping of these symptoms in typical cases of the different kinds will not now require much space. *Nephralgia,* with or without one or more small gravel-stones, is marked by high-colored, over-acid urine, dull lumbar pain, perhaps radiating to the testicle, thigh, or leg, and a few blood-corpuscles in the urine.

**A kidney-stone,** small enough to pass through the ureter, but large enough to have some difficulty in so doing, will cause a well-marked paroxysm of kidney-colic, which ends abruptly in a few hours after the seat of maximum intensity of the pain has shifted downward along the course of the ureter. The stone will probably be spontaneously voided within two or three days thereafter.

*A kidney-stone retained within the kidney* may remain there for years without giving rise to any symptoms that arouse the attention of patient or physician,* or it may cause pain more or less severe and persistent, hæmaturia and the other abnormal conditions of the urine that have been mentioned, and may lead to pyelitis, pyelonephrosis, hydronephrosis, perinephritic abscess, and uræmia.

**Course and Prognosis.**—The course and prognosis vary in accordance with the conditions already described. An individual who heeds the warning given by over-acid urine, nephralgia, or the passage of gravel or of a kidney-stone, and modifies his mode of life and diet accordingly, may pass the remainder of his life undisturbed by a recurrence; and, indeed, many a man has clung to his habits of self-indulgence for years, and yet shown no other sign and paid no other penalty of his nephrolithiasis than more or less frequent recurrences of the "gravel." So long as the crystals and small stones pass out through the ureter without much delay, the affection usually remains in that stage except for the slow contracting changes in the kidney, which are as much the result of the diathesis as of the local irritation. The one early danger that lies in his path is the arrest of some of the gravel or of a small stone in the bladder and the formation of a vesical calculus. It may happen that the persistent irritation of the pelvis sets up a catarrhal and then a suppurative pyelitis, and the course and prognosis are then those of that grave affection.

If the stone remains in the kidney, various widely different results may follow: it may be perfectly tolerated from the beginning and give rise to recognizable symptoms at no time; or, after weeks or months of pain, it may become encysted or immovably fixed, and thereafter give rise to no symptoms and have apparently no influence upon the patient's health.

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* At the autopsy of a middle-aged patient, who died in my service at Bellevue Hospital about three weeks after admission, with "spontaneous" fracture of both thighs, and who presented no symptoms of kidney trouble, a large stone was found in the pelvis of each kidney, one weighing (dry) 152 grammes, the other 59.

Or it may occasion frequent and violent paroxysms of kidney-colic, which, if allowed to continue, threaten life by exhaustion, and by inflammatory changes in and about the kidney. Or, finally, it may excite a suppurative pyelitis. The prognosis in the last two conditions has been greatly improved of late by nephrolithotomy and nephrectomy.

**Diagnosis.**—The diagnosis of certain forms of nephrolithiasis is easily made, that of others may be very difficult. It is usually easy to recognize the diathesis that is associated with the common forms, the over-acid urine, and, of course, the passage of gravel or small stones. It may also be easy to recognize a pyelitis, but very difficult to determine whether or not a stone is present, or, if present, whether it is the cause or the effect of the pyelitis. In the earlier stages of the affection the diagnostic problem is to determine the presence or absence of over-acid urine, of gravel, or of small stones; in the later stages it is to determine the presence and extent of important changes in the kidney and the cause thereof. Other and very difficult diagnostic questions may arise in connection with complications or with the predominance of certain symptoms.

The symptoms by which the earlier stages may be recognized are generally definite enough when they are all present, but some of them are closely simulated by those of other affections, and if all are not present the diagnosis may be difficult. Thus, high-colored urine that deposits numerous uric-acid crystals on standing or becomes very turbid on cooling, unilateral lumbar pain, and urgency and frequency of micturition, clearly indicate irritation of the kidney and a condition of the urine that makes the formation of gravel or of a calculus possible, perhaps even probable. If to these are added radiation of the pain to the groin and testicle, distinct tenderness of one kidney on pressure, and some blood in the urine after exercise, or, if blood is habitually present, its diminution or disappearance after rest in bed for a day or two, the diagnosis of a kidney-stone may be made with considerable assurance; and if the history of the patient reveals that he has previously (perhaps long before) passed gravel or small stones, all doubt may be dismissed.

Actual paroxysms of renal colic seldom offer any difficulty, for proper attention to the symptoms will ordinarily distinguish them at once from other conditions with which they might be confounded, such as hepatic or uterine colic, ovarian neuralgia, or a local peritonitis in the iliac fossa. A stone lodged in the ureter near the brim of the pelvis might be confounded with an appendicitis. The diagnosis from intermitting hydronephrosis, due to slight displacement of the kidney and kinking of the ureter, may be made by the absence of hæmaturia and by the sudden relief by manipulation or change of posture.

These symptoms, occurring separately, have much less significance. Lumbar pain may be neuralgic, showing maxima at certain points distant from the kidney; or it may be that of a lumbago, and will then be aroused or increased by pressure upon the lower part of the erector spinæ or by movements of the trunk; or it may have its origin in the kidney, but in some condition other than that now under consideration.

Tenderness of the kidney on pressure indicates only sensitiveness or inflammation independent of the cause; for example, it may be tubercular. Le Dentu says that methodical percussion along the twelfth rib, and laterally in the flank, causes pain in lithiasis but not in neuralgia, and is very valuable for differential diagnosis.

Blood in the urine may have many other sources than the kidney, and even after its origin at that point has been established the nature of its cause has still to be determined, for renal hæmaturia is not only a symptom of several other renal affections than calculus, such as malignant or tubercular disease, but it may be occasioned by certain drugs and by certain general or constitutional conditions.

Frequency and urgency of micturition suggest renal disease only after origin in the bladder has been excluded, and do not indicate the kind.

If the symptoms are severe and persistent, and are not relieved by measures which diminish the acidity of the urine or favor the escape or possibly the dissolving of small stones, an exploratory incision in the loin, to determine the presence of a calculus and to remove it if found, is justifiable. An additional warrant for making this exploration is supplied by the relief it has given in a number of cases in which no stone was found. After the kidney has been exposed, the search for the stone is made by palpation and by puncture with a needle. Possibly further experience will confirm the growing confidence in the rapid and complete healing of wounds of the substance of the kidney, and it will be deemed proper to extend the search directly into the pelvis and calices by incision through the parenchyma. (For details of the operation, see Nephrotomy.)

The conditions found in the later stages—pyelitis, pyo- and hydronephrosis, perinephritic abscess, etc.—will be recognized by the corresponding symptoms, to be subsequently considered. Their relation to calculous disease can be established by the history of the case and by examination of the urine, for urine containing pus from a pyelitis is acid, and will remain for days, and sometimes even for weeks, without undergoing ammoniacal change and developing bacteria; the pus settles and the supernatant liquid is perfectly clear.

*Simulated Lithiasis.*—It is to be remembered that occasionally patients seek to deceive by presenting stones which they claim to have passed with their urine. Broquiart (De la gravelle urinaire simulée, etc., Ann. des mal. des org. genito-urin., 1883) collected twenty-five cases, three of which had come under his own observation. The great majority (four fifths) were in girls or women, the remainder in boys. It is frequently associated with hysteria, and is probably connected with perversion of the sexual appetite. Ordinarily the deception can be easily detected.

**Treatment.**—Here again we must distinguish between the different forms and stages of the disease. In the early stage—that of over-acid urine, more or less nephralgia, and the threatening of stone—a moderate regulation of life and diet, with the occasional use of alkalies, will usually be sufficient. The patient must be abstemious in respect both of the quantity and the quality of the food; he must refrain absolutely from the use of malt liquors and certain wines (champagne, burgundy), should cut down on sugars, should exercise regularly but not immoderately, and should promote the action of the skin by baths and dry friction. He should drink water freely, either the common table water or the lighter mineral waters that are alkaline or diuretic. (For a detailed treatment addressed to the predisposing diathesis, the reader is referred to the more strictly medical treatises.)

The principles of treatment are essentially the same when the affection is more marked and the patient is passing sand or gravel. The formation of crystals and concretions is to be opposed, and the escape of such as form is to be facilitated. The first of these indications is to be met in the manner above stated, but the treatment must be carried out more vigorously and with more attention to detail. Game, shell-fish, spiced foods, vegetables that contain an exceptional amount of oxalic acid, such as rhubarb, asparagus, tomatoes, must not be eaten; the patient must live on milk, eggs, beef, mutton, chicken, fish, rice, potatoes, bread. The use of tea, coffee, and alcohol must be guided by consideration of previous habits and the general condition.

In the choice of a mineral water there are two main points to be considered: First, whether an alkali is desired for its effect upon the system, upon the nutritive and metabolic processes, as well as directly upon the acidity of the urine; and, second, whether a simple diuretic effect is desired. In the first case, the physician will resort to the stronger alkaline waters—Carlsbad, Vichy, Vals—or to some of the lithia waters; in the latter, to Contrexéville, Bethesda, Poland, or even to rain-water in large quantities.

When for any reason these waters are not available, the constituents upon which their efficiency is thought to depend, or their equivalents, may be directly administered; thus, the citrate of potash, in doses of ten to thirty grains three or four times a day, or the citrate or carbonate of lithia in doses of two to five grains. It is not proper to substitute for the diuretic waters such mineral or vegetable diuretics as niter or digitalis. It is alleged that ozonic ether (the ethereal solution of hydrogen peroxide) increases the solubility of uric acid in water, and thus opposes the formation of stone. Edes explains the action on the theory of the breaking up of the uric acid into allantoic and carbonic acid.

Whether or not the effect of the administration of certain alkalies or alkaline waters is wholly or partly to redissolve crystals and stones that have already formed in the kidney, is still an open question. It has often been observed that such administration has been followed by the voiding of much sand, gravel, or irregular small stones, and it is argued that the remedy has brought about the disintegration of a large stone, or has reduced the smaller stones to a size that could be passed through the ureter. Another hypothetical explanation of the occurrence is that the remedy has reduced the size of the stones by removing a coating of mucus; and a third is that, by reducing the inflammation or the irritability of the passage, it has quieted the spasm or increased the distensibility of the wall.

The above treatment is suitable for either form of acid gravel—that is, either the uric or the oxalic—and it is also in great part applicable to the much rarer hard phosphatic gravel or stone. In the latter the alkalies may yield place to the diuretics, and, in addition, the special cause of the phosphaturia must receive attention. Soft, secondary, phosphatic gravel, that dependent upon ammoniacal fermentation of the urine, is an exceptional and usually a wholly unimportant epiphenomenon of serious suppurative disease of the kidney, and its treatment is subordinate to that of the latter. In cases in which palliation alone can be attempted, the fermentation may be measurably restrained by the internal administration of the benzoate of soda, salol, or similar remedies.

Pain that is too severe and continuous to permit waiting for the somewhat tardy effect of the above regimen may be relieved by anodynes, hot baths, and hot applications to the loins. Antipyrine has been recommended as more efficient than opium under these circumstances.

In paroxysms of kidney-colic the pain is too violent for any dallying with half-measures. Morphine must be at once given subcutaneously, and, if that fails to relieve, ether or chloroform must be resorted to. Under their influence the patient is kept quiet and half unconscious, and the paroxysm is apparently shortened, for the relief of pain (and with it, presumably, of spasm of the muscular coat of the ureter) is the most efficient means we possess to hasten the passage of the calculus to the bladder. It has been proposed that large quantities of water be drunk in order to create a greater pressure of urine behind the stone and thus force it along; but as the patient usually vomits constantly during the paroxysm, the treatment could hardly be carried out, even if its efficiency and safety had been demonstrated.

The grave and fortunately very rare complication of obstruction of the ureter by a calculus, when the other kidney is already incapacitated or destroyed, may call for prompt surgical interference because of the imminent danger to life. Either the obstructing calculus must be removed, or a way for the escape of the urine must be opened above it. The first of these alternatives will be discussed in the section on the surgery of the ureter; the second can be met by a lumbar nephrotomy, with incision of the pelvis of the kidney. This has the advantage of being a comparatively simple and safe procedure, and it may even be possible for the surgeon to remove the obstructing stone by the aid of forceps passed down the ureter, or by the reflux of a stream of water directed into it. By its aid, also, time may be gained, and perhaps a more favorable opportunity for direct approach to the ureter.

*Surgical interference* is called for when a stone is lodged (or thought to be) in the kidney, and has given rise to important symptoms which have not been relieved by prolonged use of the measures above described; or when suppurative or obstructive changes have taken place and have produced conditions that seriously interfere with health or comfort, or actually threaten life. The interference may be an *exploratory incision*, in search of a stone; or a *nephrolithotomy*, the removal of a stone; or a *nephrotomy*, incision of a diseased kidney for the drainage of purulent or cystic collections; or a *nephrectomy*, removal of the kidney. Morris thinks it desirable to distinguish sharply between nephrotomy and nephrolithotomy, to limit the use of the latter term to cases in which the operation is done primarily for the removal of a stone from a (in the main) healthy kidney, and to use the former to designate operations in which the main indication is the incision and drainage of a seriously diseased kidney, and the following removal of a stone, if one is found, is secondary and incidental. It is clearly desirable that the cases should be differentiated; but it seems improbable that it will be done by this use of the terms, for it is already usual to describe as a nephrolithotomy any operation in which stone is removed from the kidney without regard to the extent of disease of the organ or to the primary object of the operation.

The justification of an exploratory operation must be found, if at all, in the value of the remedial measures made possible by the information which it furnishes. The remedial measure in the circumstances we are considering is the removal of the stone discovered by the exploration, consequently the exploratory operation must stand or fall with nephrolithotomy. The latter, using the term in the narrow sense recommended by Morris, is of recent origin, having been first done in 1880 by Morris; but it has already been proved an efficient and safe operation;* and as the exploration itself, in case a stone is not found and the kidney is not incised, has even less risk, it may, I think, very properly be resorted to with even less hesitation than is usually shown. I refer, of course, to the lumbar operation, not to the one in which the kidney is approached through the peritoneal cavity. Few, I think, would be as conservative even as Le Dentu, when he says that "after a long continuance of the pain, or the frequent recurrence of paroxysms not followed by the expulsion of stones, has shown that the spontaneous or medical arrest of the affection is not to be hoped for, and after the long series of counter-irritants has been exhausted—iodine, the actual cautery, moxas—then begins the *rôle* of surgery." Unwelcome as is the suggestion of the knife, the actual suffering and danger involved in the resort to it is infinitely less than that of the ghastly series suggested in the quotation, not to speak of the prospect which it holds out of a prompt and permanent cure in the place of the simple palliation offered by the other. Morris quotes with some bitterness of tone the remark of a medical author, suggested by the occasional spontaneous escape of a calculus by ulceration through the loin: "The cautious surgery of Nature is surrounded by safeguards which rarely attend the rougher operations of art," and points out that by "Nature" is meant a prolonged, often painful, and always destructive pathological process; he suggests as a substitute for the aphorism the following: "The cautious and well-timed assistance of the surgeon is surrounded by safeguards which rarely attend the operations of disease."

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* Newman (Surg. Dis. of the Kidney, 1888) collected thirty-eight cases in which calculi had been removed by operation from otherwise healthy kidneys without a death.

Moreover, as has been already stated, the exploration has itself proved curative in a number of cases in which no stone was found, and in which nothing was done to the kidney except palpation and perhaps puncture with a needle. In one of Le Dentu's cases the needle touched stone at first, but, as it could not be found again, the operation was carried no further; the next day the patient passed several gravel-stones through the urethra, having never done so before, and remained thenceforth free from the continuous pain that had led to the operation. The case is hardly sufficient to justify Le Dentu's proposed establishment of another kind of operation, *dislodgment of stone.* In like manner, the relief which has followed in a few cases in which the fibrous capsule of the kidney has been intentionally split does not appear to have been greater than that which has followed simple exposure of the kidney; more definite experience is needed before it can be formally recommended.

It seems, then, to be justifiable to recommend an exploratory lumbar incision to a patient who is suffering with a constant or recurring pain, probably of calculous origin. It is objected that this is a confession of inability to make a diagnosis. If the inability exists, it had better be confessed; and, moreover, the measure is the only thing that holds out any promise of supplying the information that is needed for a diagnosis.

**Nephrolithotomy; Nephrectomy.**—The presence of stone having been determined, it should be removed, either alone or with the kidney. The choice depends partly upon the condition of the kidney, whether it is capable of sufficient functional activity to make its retention desirable, and if existing abscesses can be satisfactorily drained, and partly upon the possibility of making a complete and safe removal of the stone or stones. As a general rule, the kidney should be left if there is reason to believe that any considerable portion of it can do its work. If the abscesses do not heal, if a urinary fistula forms, a secondary operation can be done and the organ removed more easily, often, than by the primary operation. On the other hand, if any stone is left behind, a second operation will certainly be required for its removal, and there is no reason to suppose that its removal except by nephrectomy is any more probable than at first. The details of the operation will be described in another chapter. I shall here only call attention to the frequent difficulty of recognizing the presence of a stone, and the consequent necessity of making a very careful and systematic search for it by pressing upon all parts of the kidney with the finger, or, if possible, between the finger and thumb, in order to recognize differences of resistance, and by puncturing with a needle through almost every square centimetre of its surface. In cutting for a stone, it is better to make the incision through the parenchyma than through the wall of the pelvis; the bleeding is not severe, and the probability of the establishment of a urinary fistula is much less.

The treatment of cases in which the most prominent condition is a pyelitis, or pyelonephritis, or perinephritis, or in which a renal fistula leading down to a stone exists, will be considered in the corresponding sections.

## III. PYELITIS, PYELONEPHRITIS, PYONEPHROSIS, NEPHRITIS, TUBERCULOSIS.

### A. PYELITIS, PYELONEPHRITIS, TUBERCULOSIS.

As the result of the most varied general and local causes, an acute, subacute, or chronic catarrhal or suppurative inflammation may attack the pelvis and its prolongations or the parenchyma of the kidney, and may spread from either to the other. *Pyelitis* is an inflammation of the pelvis; a *nephritis* is an inflammation of the kidney itself; and a *pyelonephritis* is a combination of the two. In *pyonephrosis* the distended pelvis and the thinned and atrophied kidney together form the irregular lobulated wall of a cyst with purulent contents. In certain forms the affection may exist for months, or even years, without giving rise to symptoms that attract much attention, and without seriously affecting the health of the patient; in others, it is one of the last manifestations of a general and fatal illness, as in the infectious fevers, pyæmia, etc.; in others it is an extension, perhaps unnoticed or unrecognizable, of neighboring local disease, as *ascending pyelitis* following cystitis, and is dominated in importance by the latter; while in others it may be a purely local and isolated affection, as in calculous and sometimes even in tubercular pyelitis, and one which in itself deserves all the attention and care that can be given it.

It is mainly an affection of adult life, although occasionally seen in childhood, and is much more frequent in men than in women, because of the great preponderance in the former of conditions obstructive to the escape of urine from the bladder.

**Etiology.**—The most common causes are the extension of inflammation from the bladder, obstruction to the flow of urine through the ureter or from the bladder, nephrolithiasis, especially the retention of a calculus in the pelvis, and tuberculosis of the kidney. The rarer causes are traumatism, many general and infectious diseases, the ingestion of certain irritating drugs, foreign bodies in the pelvis, and possibly chilling.

The possible occurrence of pyelitis as a consequence and complication of a *traumatism* has been mentioned in a preceding chapter. Like other suppurative complications of wounds, it is the result of infection by pyogenic germs, usually through an open wound, which by providing at the same time an outlet for the pus separates this form widely from the others. The traumatism may first set up a suppurative perinephritis which ruptures into the pelvis.

Another rare local cause, somewhat akin to a traumatism, is the presence of a *foreign body*, possibly introduced from without, once a fragment of bone from the carious second lumbar vertebra, parasites of different kinds, blood-clots, malignant tumors. These appear sometimes to act by the simple irritation of their presence, at other times by interfering with the flow of the urine from the kidney and thus causing distention of the pelvis.

Certain irritating drugs—cantharides, turpentine, cubebs—may, in the course of their elimination by the kidneys after having been taken into the stomach, set up catarrhal pyelitis, which, however, is usually prompt to disappear on cessation of the cause.

The group of *general causes* contains all the acute infectious diseases, osteomyelitis, typhoid, diphtheria, puerperal septicæmia, pyæmia, cholera, etc., and also others, such as carbuncle, scurvy, Bright's disease, and diabetes mellitus. In many of these there is but little tendency to suppuration; the pyelitis remains catarrhal, and without notable influence upon the course of the primary disease; in others, the process begins as multiple foci of suppuration in the substance of the kidney, the small collections run together to form large cortical or medullary abscesses, and by the rupture of the latter into the pelvis a suppurative pyelitis is set up.

Some authors claim that a spontaneous pyelitis, the result of *chilling*, is not uncommon; thus Rosenstein attributes the frequency of pyelitis in Holland to its damp climate. Most authors quote the opinion with much reserve, although the occasional action of the cause is admitted (A. Robin, De la pyélonéphrite primitive, Gazette médicale, 1885, p. 215).

The most common local cause is *nephrolithiasis*, which can set up a pyelitis (and pyelonephritis) either by irritation or by obstruction; that is, the over-acid urine, or the recurring crystals and gravel, or the retained calculus, may irritate the mucosa of the pelvis and thus originate a catarrhal pyelitis, which may remain such for an indefinite time or may become suppurative; or the retained stone may obstruct the escape of urine from the pelvis, and give rise to the common pathological changes through the mechanism of over-distention.

The same consequences may follow obstruction of the ureter (by a lodged calculus, the pressure of a tumor, or of the gravid or otherwise enlarged and degenerated uterus), or, more remotely, obstruction to the escape of urine from the bladder (enlarged prostate, tight urethral stricture); but in the cases of obstruction to the outflow from the bladder the pathogeny is complicated by the addition of another factor, namely, the extension upward along the ureter to the pelvis of the inflammation that is first set up in the bladder by the obstruction. This class of ascending pyelites is a large one, recruited as it is so freely from the vast number of elderly men who are affected with prostatic disease, and also from those younger men who have long neglected their strictures. To it are to be added also the cases of direct extension of a gonorrhœa from the urethra through the bladder and ureter to the kidney. Whether such gonorrhœal cases are numerous, or so rare as almost to be unknown, is still in dispute. Fournier says he has never seen a case; Keyes speaks of them as not rare. I presume that all those who question the fact admit that a gonorrhœal cystitis is sometimes followed by a pyelitis, and that their denial is only of the gonorrhœal character of that pyelitis, of the presence in the kidney and direct agency of the gonococci.

A remaining and far from infrequent cause is tuberculosis; and, although the process when thus originated is essentially chronic from the beginning, it bears a close resemblance in lesions and symptoms to the other common varieties. The form of tuberculosis which we have in mind, and which alone will be here considered, is that marked by slowly developing cheesy nodules, with changes in the neighboring tissues similar to those in and about tubercular joints; we shall not consider the acute miliary tuberculosis (the *disseminated tuberculosis* of Morris) which appears by preference in the young, is characterized by multiple minute miliary nodules scattered through the organ, is usually part of an acute general tuberculosis, gives rise to no symptoms specially referable to the kidney, and calls for no special treatment.

Some idea of the relative frequency of tuberculosis of the kidney may be gained from the following statistics, although they are by no means in accord. Morris (*loc. cit.*, page 474) states that in 2,610 post-mortem examinations made in the Middlesex Hospital in the course of ten years, 44 showed tubercular disease of the kidney, of which 29 were of the miliary form and 15 of the cheesy. Steinthal (Virchow's Archiv, 1885, vol. c, p. 81) states that 28 cases of tuberculosis examined in the pathological institute at Geneva showed implication of the kidney in 18, in 16 of which the form was miliary. The latter author made a careful analysis of 24 cases of cheesy tuberculosis of the kidney, and, although the number is perhaps not large enough to justify very positive generalization, his conclusions are interesting and valuable. They are, that with tuberculosis of the kidney is always found tuberculosis of the lungs or bronchial glands, possibly quiescent, and that the latter is primary. The first infection of the kidneys is commonly in the medullary substance, at the base of the pyramids, and it spreads thence to the cortex and into the calices and pelvis. After the process has reached the free surface of the urinary passages it spreads with great facility along them, apparently by transport of the bacilli in the urine, for intervals of uninfected mucosa are found, and when the bladder is reached it develops first and most rapidly in the trigonum immediately about the orifices of the ureters. In the kidney the process may continue until the organ is completely destroyed, transformed into a bag of cheesy pus. In the pelvis and ureter the process may be ulcerative on the surface of the mucosa, or may show itself only in great thickening of the wall. The process rarely extends to the testicle, and tuberculosis of the testicle rarely extends upward to the kidney. In 12 of the 24 cases both kidneys were involved, but not to the same degree. Of Morris's 15 similar cases both kidneys were involved in 8; the ages show the affection to be one of young and middle adult life, although it occurs in the old.

**Pathology.**—From the anatomical stand-point the different forms of pyelitis may be classified, following Cornil, as (1) catarrhal, (2) acute or chronic purulent, and (3) calculous.

The *catarrhal* form shows a thickened and injected mucosa with rapid formation and desquamation of the epithelium, and the process involves also by direct propagation the tubules of the pyramids. In the more severe forms there is a fibrinous exudation, that adheres in part to the surface and in part is carried away as shreds in the urine.

In the *acute purulent* form there is a round-cell infiltration of the wall of the pelvis, the mucosa is greatly thickened and irregular, with numerous small extravasations of blood and scattered points of superficial sloughing and ulceration. The kidney substance on section shows small white streakings through cortex and medulla, and later punctate foci of suppuration or larger abscesses formed by confluence of the small ones. The suppuration appears to begin in the pyramids by the agency of bacilli that have made their way directly into the tubules from the pelvis. The pus that forms on the free surface is either carried away in the urine, or, if the ureter is obstructed by the inflammatory swelling of its own wall or by a fibrinous plug, it collects within the pelvis.

The *chronic purulent* form may be the later stage of the acute, or it may be chronic from the beginning. It gradually destroys the parenchyma of the organ, partly by suppuration and partly by the formation of interstitial connective tissue, and as the escape of the contents of the pelvis through the ureter is always opposed and at times entirely prevented, more or less distention of the kidney ensues. The resistance of certain portions of the parenchyma to this distention causes it to be irregular, with formation of pouches of variable size separated by partitions and spurs often of notable thickness (Fig. 5). The mucosa may be smooth,

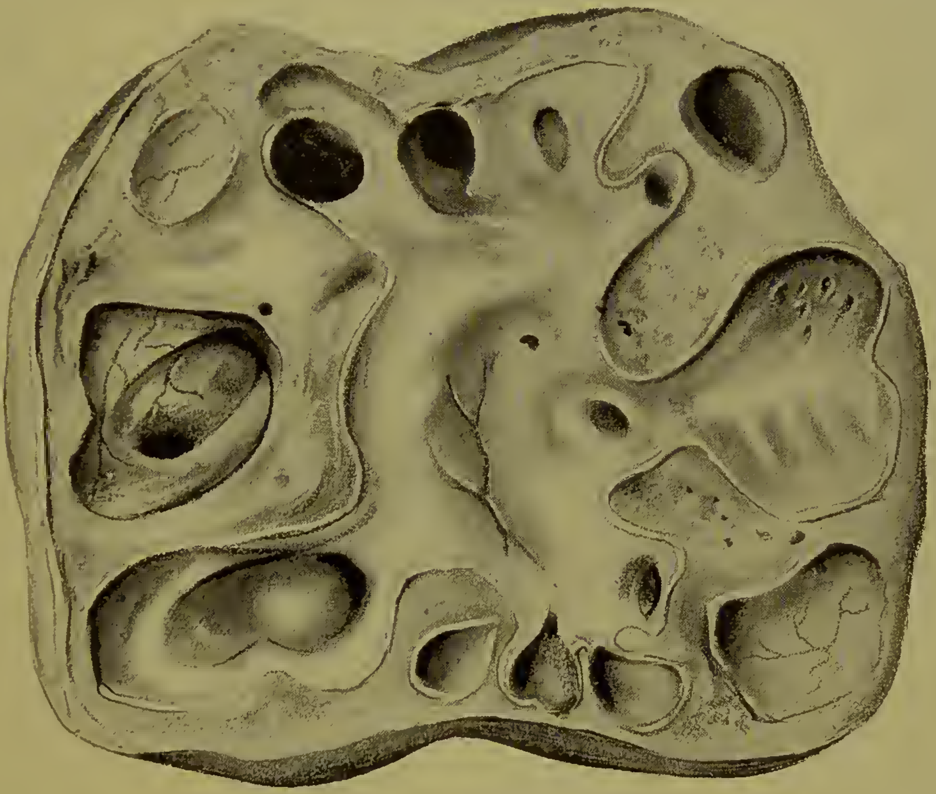

FIG. 5.—Calculous pyelitis. (Rayer.)

velvety, or papillomatous, pale, injected, or so vascular that hæmorrhages are frequent and profuse.

If the obstruction to the escape of the contents is permanent, the condition becomes that known as *pyonephrosis*, and the kidney is transformed into a vast irregular sac filled with pus.

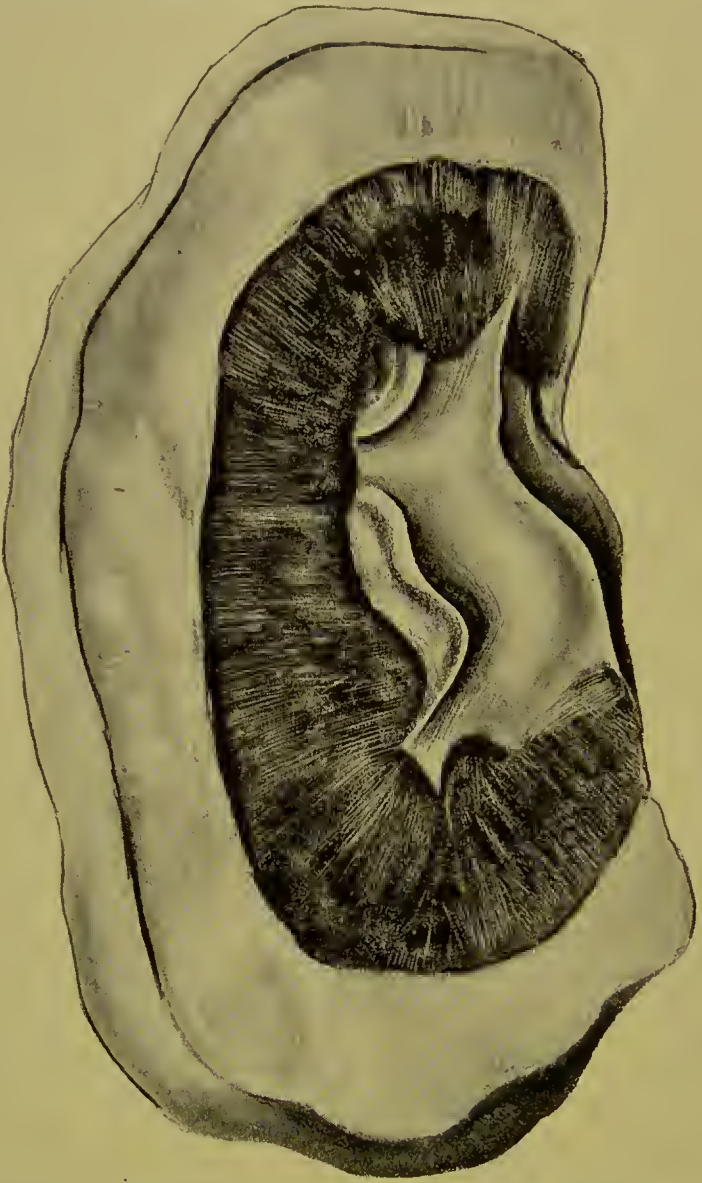

FIG. 6.—Pyelonephritis; the outer layer is the thickened and condensed fatty capsule. (Rayer.)

The process involves the adjoining tissues either by ulceration and perforation of the wall of the pelvis, or perhaps simply by bacillary infection, with production of a perinephritic abscess, or more slowly by direct non-suppurative extension, with constant thickening and condensation of the fatty capsule, that may be so marked that it is transformed into a thick, fibrous layer that bears no resemblance to its normal condition (Fig. 6). The same process may result in the formation of abnormal adhesions to neighboring parts, such as the peritonæum, loin, intestines, and vena cava, that create important difficulties and dangers in case nephrectomy should be attempted.

In case the imperfectly evacuated urine undergoes ammoniacal fermentation, the triple phosphates are formed and precipitated, often in large amount; they may form a putty-like mass, or adhere to the wall, or mat together in large, friable stones.

The *calculous* pyelitis is restricted to those cases in which the formation of the stones precedes and causes the pyelitis, in contradistinction to those just mentioned, in which the formation of a phosphatic stone is a late epiphenomenon in the course of a pyelitis. The pyelitis thus set up is at first catarrhal, and may long remain so, and, as was explained in the preceding chapter, may be so slight as to give rise to few or no recognizable symptoms. It may, however, become suppurative, and is thought to be more especially prone to ulceration and consequent perinephritic abscess. The sudden and permanent blocking of the ureter by the calculus occasions prompt distention of the pelvis by the urine that is subsequently secreted (hydronephrosis); this may result in a simple interstitial, non-suppurative nephritis, with progressive atrophy of the parenchyma, or, in case of bacillary infection, in diffuse or circumscribed suppuration.

In the *tubercular form* the process begins, as has been said, with the formation of one or several nodules (ultimately cheesy), usually in the medulla, at the base of the pyramids, but occasionally in the cortex; if suppuration ensues in them, the nodules become abscesses, and, according to the varying activity of the process, either remain as independent, purulent, cheesy foci, or coalesce. At the same time new nodules form and pursue the same course, with increasing destruction of the parenchyma, and finally rupture to the exterior, or more commonly into the pelvis. The destruction of the kidney may be complete, the thickened and tubercular capsule inclosing only pus or a mass of friable or putty-like, cheesy matter. The wall of the pelvis and ureter is greatly thickened by tubercular degeneration, and the mucosa correspondingly degenerated or ulcerated.

**Symptoms.**—In describing the symptoms of pyelitis and pyelonephritis, it will be advantageous to treat separately of the acute forms; of those chronic ones in which the affection is of local origin and uncomplicated by disease of the bladder; and, finally, of those, the "ascending" cases, in which it is a complication and result of cystitis.

In the *acute form*, which is rare, the onset may be sudden, with chills, headache, fever, nausea, the usual signs of an acute visceral inflammation, accompanied or promptly followed by local signs and changes in the urine which show the kidney to be the organ involved, namely, pain in the loin, tenderness on pressure upon the kidneys, frequency of micturition, increase of mucus in the urine, possibly hæmaturia, and the presence of the small, tailed, imbricated epithelial cells characteristic of the pelvis. If the case is one of pyelonephritis, the urine is diminished in quantity, and albuminous.

In the *chronic form of local origin*—for example, the pyelitis of nephrolithiasis—the catarrhal stage is marked mainly by nephralgia and local tenderness and by changes in the urine, which latter become more marked and varied as the affection passes into the purulent stage. The quantity of the urine may be notably increased, at first without change in its appearance, but later it becomes turbid by the admixture of pus. *It remains acid*, and if allowed to stand may retain its acidity for days, while the pus sinks to the bottom of the vase and there forms a greenish, oily-looking stratum; and the supernatant urine remains perfectly clear, without development of bacteria—a group of characteristics which absolutely distinguish the affection from any of the forms of cystitis. There may be a few exceptions to this rule, as where the kidney is almost destroyed as a secreting organ, and the urine, retained for a time within its dilated pelvis, has had an opportunity to undergo ammoniacal fermentation. The urine is albuminous, sometimes more so than the amount of pus would account for, and contains mucus, pus, possibly blood, and epithelial cells, which are thought to come from the tubules of the kidney and to be pathognomonic of the affection. These cells are round, with a single nucleus, and about one half larger than a leucocyte. Accepting the theory of their origin in the tubule, their presence indicates the extension of the inflammation to the parenchyma of the kidney. Some of the pus-cells also are agglutinated in short, cylindrical masses, as if they too had come from the tubules. The amount of pus in the urine may vary from day to day, and may even be intermittent, the intermittences coinciding with exacerbation of the local and general symptoms, and being due to the temporary obstruction of the ureter.

The amount of blood in the urine varies greatly in the different cases and at different times in the same day. It is habitually absent in some, habitually present in others, and is most frequent and most marked in calculous pyelitis, in which it is easily produced or increased by such causes as sudden movements, muscular efforts, and jolting. The blood, when in small quantity, is uniformly distributed through the urine; when abundant, it may be in clots which are sometimes long and cylindrical, as if formed in the ureter.

Dull pain in the loin is constant, with occasional exacerbations; to it may be added the pain excited by the presence of a calculus, or by the difficult passage through the ureter of a large fibrinous plug.

More severe pain is provoked by pressure upon the kidney through the anterior abdominal wall, or by percussion in the loin and along the floating ribs.

Bimanual palpation may show the kidney to be enlarged; and if a perinephritic abscess has formed, it may cause a swelling in the loin that is recognizable by the eye as well as by the hand.

The general symptoms vary greatly. So long as suppuration is absent or slight, the general condition remains fairly good; but as the disease advances the health deteriorates, there is fever every evening, chilly sensations, perhaps a regular chill; the patient loses his appetite, and grows pale, thin, cachectic.

In the *ascending chronic form*, that due to extension of inflammation of the bladder, the same symptoms are present, but they are in great part masked by those of the cystitis; and, as Morris says, "pyelonephritis, when secondary to disease of the bladder, is too often unrecognized until discovered at the post-mortem examination." The frequency of micturition, the pus, mucus, and blood in the urine, the fever, and the deterioration of the general condition, are all equally symptoms of cystitis, and the ammoniacal change which the urine undergoes in the inflamed bladder destroys the combination of pus and acidity which is so characteristic of pyelitis, even if the ammoniacal ferments have not already made their way up to the kidney. There remain only the local symptoms in the region of the kidney to point to its association in the disease. It may be said, however, that a sudden change for the worse—fever, dry tongue, quick, small pulse, chills, prostration—in a patient who has long been suffering with cystitis, especially of obstructive origin, clearly indicates the appearance or the dangerous increase of a pyelonephritis.

The following description of such patients is quoted from Hallé: "Pale, with yellow, earthy, dry skin, our patients rapidly lose strength and are soon confined to the bed. The digestive functions are profoundly affected. Appetite is completely absent; there is often even an actual repugnance for food. Only liquid food can be taken, and the digestion of that is often difficult. Nausea and gastric distress at once follow the least attempt to take solid food. On the other hand, thirst is great. The tongue, usually white and coated, becomes red and dry during the febrile exacerbations, which ordinarily indicate extension of the nephritis. Fever is not constant. There are long periods of apyrexia, especially when the affection is left to take its natural course. Then, there are irregular febrile movements, the cause of which is always easily to be found. A transient retention of pus in the kidney, the slightest surgical traumatism inflicted on the urethra, causes a chill and high fever."

**Course and Prognosis.**—These are largely determined by the cause of the affection and by the extent to which the kidney parenchyma is involved. The acute forms due to the action of irritating drugs cease promptly on the cessation of the cause. Those that occur in the course of infectious diseases are rarely severe or serious in themselves except when the primary disease is almost inevitably fatal. If the patient can recover from the latter, the pyelitis is not likely to last long or to give him much trouble.

There is a similar relation with the cause in the chronic form. A calculous pyelitis will last so long as the stone remains in the kidney, and one that is the result of an obstruction in the ureter or urethra will last while the obstruction remains. Unfortunately, we can not add that it will always cease on the removal of the cause, but the affection may persist in one form or another even for years without endangering life. This is especially the case when only one kidney is involved, and when the process in it has advanced so far that the function is entirely abolished, and the organ is reduced to a sac of inspissated pus, or to a shrunken abscess wall that discharges a moderate amount of pus through some spontaneous or artificial opening. Such suppurating sinuses are, of course, as potential for evil when they lead to a degenerated kidney as when they have originated under other circumstances. There is the same possibility of retention of the pus, of septicæmia, amyloid degeneration, erysipelas, etc.

Cases are not uncommon in which a pyelitis that had advanced even to the condition of a pyonephrosis has ceased to give any symptoms after a single or perhaps repeated evacuation of its contents through the ureter, or through a spontaneous opening into the intestine or the lungs or through the skin. Strange as it may seem, not a few cases of recovery by spontaneous opening into the lung and evacuation of the pus through the mouth have been reported. Opening into the intestine is thought not to be quite so favorable; that through the skin of the loin more so. Still, the prognosis in all purulent cases without surgical treatment is bad. It is worse in some than it is in others. It is worse when both kidneys are involved, worse in pyelonephritis than in pyelitis, and worse when the pus is fetid and can not be freely evacuated. Under surgical treatment the prognosis is notably improved, and in some cases it may be fairly claimed that the interference restores the patient to health. Even if it does not do so much as that, it often removes an immediate serious danger and enables the patient again to become self-supporting. The benefit is particularly clear in calculous and tubercular pyelitis. In the one, the removal of the stone is the removal of the cause, and may be followed by complete restoration to health; in the other, the removal of the diseased organ—nephrectomy—is the removal of a focus of incurable disease, and, while it may not prevent later manifestations of that disease at other points, there is good reason to believe that it delays them, and that it has prevented in a considerable proportion of cases an early outbreak of miliary tuberculosis.

**Diagnosis.**—The difficulties in diagnosis are mainly found in distinguishing between pyelitis and cystitis, or in recognizing the co-existence of the former with the latter and in distinguishing between the different forms and causes. Not to repeat the account of the symptoms already given, I shall only call attention again to some of the more important diagnostic points.

Pyelitis has, in common with cystitis, frequency and urgency of micturition, pus, mucus, albumen, and blood in the urine, and in the severer forms the general symptoms associated with fever. The distinguishing features (not all present in every case, of course) are, in pyelitis, sudden changes in the amount of pus; the presence in the urine of epithelial cells peculiar to the kidney, and of cylindrical masses of agglutinated pus-cells resembling urinary casts; acidity of the urine, which persists for several days if the urine is allowed to stand; absence or very tardy appearance of bacteria in the standing urine, and consequent clearness of the urine above the thick, greenish, oily deposit; purulence of the urine drawn by the catheter during ten or fifteen minutes immediately after the bladder has been thoroughly washed; pain and tenderness on pressure in the region of the kidney, and perhaps its recognizable enlargement.

The intercurrence of pyelitis in the course of a cystitis is indicated by a sudden change for the worse, especially if the patient has just been subjected to some instrumentation or operation upon the urethra or bladder. The characteristics of the change have been described above.

Ascending pyelitis, calculous pyelitis, and tubercular pyelitis are to be distinguished from one another mainly by the clinical history. In the first, if the patient is an elderly man, there is enlargement of the prostate and a cystitis; if younger, a long-existing tight stricture of the urethra, or a history of gonorrhœa and cystitis. In the calculous form there may be a history of the passage of gravel or of nephritic colics, perhaps many years before. In the tubercular form there is the family history, possibly evidence and history of tubercular trouble in other organs, and possibly the recognition of tubercle bacilli in the urine by the microscope, or their demonstration by inoculation upon an animal.

If the kidney forms a large tumor, and the question is between a pyonephrosis and a solid tumor, the aspirating-needle should prove the presence of pus, and possibly of stone or tubercle, or an exploratory incision make the condition plain, and at the same time prepare the way for appropriate treatment.

**Treatment.**—The principle of treatment which indicates the removal of the cause of disease wherever practicable, and when the cause is a continuing one, has an important corollary in the present instance, namely, *prophylaxis.* The prevention of pyelitis is possible to a considerable extent in those classes which furnish the largest number of cases—the calculous and ascending forms. For the former the reader is referred to the chapter on Nephrolithiasis, to the measures recommended to correct over-acidity of the urine and diminish the tendency to the formation of stone. In the latter, in which the pyelitis is secondary, through cystitis, to an obstruction to the flow of urine from the bladder, especially enlargement of the prostate and stricture of the urethra, prophylaxis consists not merely in the removal of the obstacle or the cure of the cystitis, but also in the removal in such a way that it will not itself be the occasion for the outbreak which it is designed to prevent. It will be remembered that a slight urethral traumatism or surgical operation upon the urethra or bladder is often the immediate determining cause of pyelitis in those who have been prepared for it by long-continued obstructive disease of the bladder or urethra. Consequently, such operations must be avoided so far as possible, and, when necessary, must be done in such a way as to reduce the risk to a minimum. The urinary passages should be disinfected, so far as that can be done, by the internal administration of drugs. Among those which are believed to be thus efficient are salol, the benzoates, and especially diurethin, or, what appears to be its equivalent, sodio-salicylate of theobromine, in ten-grain doses every four hours. If the cause of the obstruction is a deep stricture of the urethra, it should unquestionably be divided only by perineal section. Internal urethrotomy or divulsion is full of danger. Chloroform is to be preferred to ether, and local anæsthesia by cocaine is vastly better. If the patient is an old man and the obstruction is at the prostate, if there is considerable residual urine, or if the cystitis is severe and the urine fetid and ammoniacal, suprapubic cystotomy is, in my judgment, much the safest way to establish drainage and disinfect the bladder.

In the acute pyelitis of cantharides, turpentine, etc., and the rare spontaneous form, rest in bed, diluent drinks, hot fomentations, an alkali to diminish acidity, and enough opium to relieve pain, constitute the treatment; and there is not much more to be added for the general and internal treatment of the chronic forms. Difficult as it may be to appreciate it when we think of the marked alkalinity of the urine when it is passed, it is habitually acid at the kidney, and the administration of an alkali will ordinarily relieve pain and diminish the urgency of other symptoms. Benefit sometimes appears to follow the administration of tannic acid in two-grain doses when there is much mucus, and of small amounts of quinine and opium (Morris). When there is polyuria, Morris recommends ʒ ss. doses of the liquid extract of ergot. The muriated tincture of iron in large doses has also been claimed to have a beneficial effect.

The surgical treatment includes measures undertaken to remove obstructions to the free escape of urine from the bladder, to relieve cystitis, to remove renal calculi, evacuate renal abscesses, or to remove the kidney itself.

The methods employed to carry out the first two indications will be described in other sections of this book, and we have here to consider only the indications for nephrotomy, or nephrolithotomy and nephrectomy.

Nephrolithotomy is clearly indicated in calculous pyelitis when the general condition is seriously affected by persistent pain or suppuration, or by the establishment of a pyonephrosis, which is in itself an indication for surgical interference. Probably a near future will establish wider indications for the operation, and show the advisability of the removal even of stones that cause but few symptoms. Occasionally it will happen that the calculi are so numerous, and so encysted or so adherent, that it will seem better to remove the kidney, to do a nephrectomy rather than a nephrotomy. The relative advantages of the two operations will be discussed in detail elsewhere, and it is sufficient here simply to indicate some of the points to be considered. On the one hand, there is always a doubt as to the condition of the other kidney and its ability to do all the work that would be thrown upon it by the removal of the first, and there is the greater danger to life; on the other hand, it can be claimed with some justification that if any stone is left the operation is practically a failure, that the pyelitis will persist, with an added sinus. Increased experience will probably enable us to draw the lines more sharply.

The second clearly established indication for surgical interference is found in the existence of renal abscess, pyonephrosis, with marked general symptoms; and here, too, the choice is between nephrotomy and nephrectomy. Probably here, too, increasing experience will show the advisability of interfering even when general symptoms are not marked, for a change for the worse may rapidly supervene, and a condition arise in which operation is powerless to save. The conditions or symptoms which are at present accepted as positive indications for operation are intermittent pyuria, with fever during the intermissions, persistent fever, and other signs of septicæmia, notwithstanding the constant escape of pus and increase of the tumor coincident with the disappearance of pus from the urine.

The preferable operation, in the light of our present knowledge, is clearly nephrotomy. Aspiration may relieve temporarily, and repeated aspiration may occasionally cure, but nephrotomy is not more dangerous, and is more efficient. As between nephrotomy and nephrectomy, the choice is at present decidedly in favor of nephrotomy as the easier and safer operation, and also because it makes a subsequent resort to nephrectomy safer than if that operation had been done primarily. This is satisfactorily established by the statistics already at hand. Doubtless there are cases where the kidney is so completely destroyed as a secreting organ, and where it is so loosely held within its fatty capsule, that its removal involves no additional risk, and, as it favors rapid and complete recovery without persistent fistula, it is then to be preferred. There was a tendency at first to make it a rule that if both kidneys were diseased only one of them should be operated upon, and the operation should be a nephrotomy; but experience has not only confirmed the frequent difficulty of determining the condition of the second kidney, but it has also shown that nephrectomy can be successfully done when the second kidney is undoubtedly diseased. The extent of the disease in the kidney to be operated on is of more importance in determining the choice, for if it has wholly lost its function as a secreting organ, its removal is not the removal of a kidney, physiologically speaking, and throws no additional work upon the other.

In tubercular disease fairly limited to the kidney, nephrectomy finds a special indication, the removal of a focus of disease in which a general infection may originate. König thinks the operation is clearly called for, and adds that its execution appears to be somewhat easier because of the loose attachment of the fatty capsule to the kidney in these cases.

### B. PRIMARY SUPPURATIVE NEPHRITIS.—GANGRENE OF KIDNEY.

Primary suppuration of the kidney is very closely allied by its causes and symptoms to pyelitis, and the only forms in which surgical treatment is indicated are those in which the differential diagnosis, even post-mortem, is difficult or even impossible.

The affection usually appears as a complication and result of the more serious infectious fevers—typhoid, osteomyelitis, ulcerative endocarditis, diphtheria, pyæmia, and septicæmia, especially when it has originated in disease of the bladder or urethra. It is therefore an infectious disease in a stricter sense than that which would include all suppurations. It may also follow a traumatism of the kidney limited to the parenchyma.

The suppuration may be diffuse or circumscribed, with the formation of a larger or smaller abscess. In the former case the kidney on section is yellow, exudes pus on pressure, and is friable; the microscope shows a general round-cell infiltration and a tendency to the collection of the leucocytes in miliary abscesses; if sufficient time elapses, large abscesses may form, giving the kidney an appearance similar to that observed in some forms of pyelonephritis—that is, it is a mass of cavities separated by complete or incomplete septa, and containing pus. The circumscribed form may be a stage of the preceding, the coalescence of miliary foci to form a few abscesses, or it may be the result of an infection limited to a few points, with the same result.

Ordinarily these abscesses increase until they open into the fatty capsule or into the pelvis, or more rarely into the peritoneal cavity or the intestine; but they may cease to grow, and undergo partial absorption and caseation of the residuum. It is claimed also that transformation into a serous cyst is possible.

**Symptoms.**—The symptoms are in the main those of severe pyelonephritis, except for the absence at the beginning of pus or renal epithelium from the urine; these appear as soon as the pelvis becomes secondarily involved and the abscess opens into the pelvis. The general symptoms are severe—high fever, chills, lumbar pains, and perhaps the rapid development of a typhoid condition. In the chronic form the symptoms may be less severe and too vague to permit diagnosis.

In two cases quoted by Simon (*loc. cit.*, second part, page 173) a piece of the kidney of considerable size, one weighing 20 grammes, the other as large as a pigeon's egg, was passed per urethram. One patient recovered; the other died eleven weeks later, and the autopsy showed that both kidneys were affected, and that in each there were several half-detached fragments similar to that which had been voided; this patient was a boy eleven years old, and the nephritis was secondary to an attack of scarlatina.

Gangrene of the whole or a large part of the kidney has also been noted.

**Treatment.**—The treatment at the beginning can be only symptomatic, even if a diagnosis that is more than a suspicion can be made. If the patient survives long enough, and the abscess grows to a sufficient size to be recognizable, or if it breaks through and becomes a perinephritic abscess, the evacuation of its contents by the knife is indicated. The condition then is so nearly that of a pyonephrosis that the same principles govern the method of treatment.

## IV. PERINEPHRITIS, PERINEPHRITIC ABSCESS.

By perinephritis is meant an inflammation in the connective and adipose tissue about the kidney. Although the condition was known to the ancients, and is mentioned by several of the older classical writers, the first systematic description was by Rayer (1839), and it is only since 1860 that it has received much attention. It is apparent, too, I think, that much that has been written about it will need revision, especially in respect of the classification and etiology; for some of the recorded cases, described and quoted as perinephritic abscesses of "spontaneous" or unknown origin, appear now to have belonged to that affection, appendicitis, of which our knowledge has so greatly increased during the last few years.

The pus that has formed about an inflamed and perforated appendix not infrequently spreads upward to and is opened in the region of the kidney; it is to that extent a "perinephritic abscess," "an abscess in the connective tissue about the kidney," but nothing is to be gained, and much may be lost in precision of knowledge and in treatment, by grouping such cases with those which originate in the neighborhood of the kidney, by giving them a name which suggests a kidney origin, and by taking them out of the class of inflammations of the appendix. So, too, in the case of inflammations in the region which originate in some other organ than the kidney, as the liver, the intestine, the body of a vertebra, it seems to me desirable to classify them in accordance with their origin rather than with the accident of their location, although, of course, so long as that origin remains unknown we can have no other name for them than perinephritis. It has been proposed to give them a name which defines the situation equally well, and yet conveys no suggestion of origin—to call the affection *abscess of the lumbar fossa*. The suggestion has been accepted by some writers of authority, but has not yet established itself. With this reservation we may follow the usual etiological classification, and group the varieties of perinephritis as follows (Le Dentu):

1. Primary perinephritis.
    - *a.* Traumatic.
    - *b.* Spontaneous.
2. Secondary perinephritis.
    - *a.* Due to a general cause (infectious perinephritis).
    - *b.* Due to a local cause (perinephritis by extension).

**Etiology.**—Perinephritis may be caused by a local traumatism, or by the extension of an inflammation or the burrowing of pus from the kidney or other adjoining organ, or, apparently, by the local action of some general infection, or of some undetermined influence which excites suppuration in the fatty capsule of the kidney. It is in this last group that the probability of error through failure to detect the actual cause, already referred to, exists.

As predisposing causes may be mentioned those which favor the occurrence of suppurative inflammation of the kidney, as tuberculosis or the gouty diathesis, with its tendency to over-acid urine and the formation of stone or gravel. The alleged predisposing influence of certain modes of life, and occupations which call for violent and repeated muscular efforts and expose to cold and wet, is probably exerted, if at all, through traumatisms or through a depravation of the general condition which favors the action of some specific cause. In some cases the pre-existence of some affection of the kidney, such as a calculus or tuberculosis, has clearly enabled some comparatively slight traumatism to provoke suppuration.

The determining causes of the primary forms are traumatisms (open wounds, contusions, and larger or smaller extravasations of blood caused by exaggerated displacements of the kidney in jolts and violent efforts) and exposure to cold and wet. Open wounds involving the kidney have been considered in another chapter; those that extend into the fatty capsule but not into the kidney provoke suppuration, as do other primarily or secondarily infected wounds; and the only features of special interest in the process are those that are connected with the depth of the wound, with the laxity of the connective tissue, and with the ease of propagation to other parts—features that are shared with suppurative processes in the same region arising from other causes, and will be subsequently considered.

Contusions are deemed a relatively frequent cause. Le Dentu attributes to them one quarter of the primary cases. In some cases, especially those in which a long period—many months—has elapsed between the contusion and the first symptoms of perinephritis, the causal relation can not be accepted as proved, and in others there is evidently present a predisposing cause which has favored the action of the violence. Thus Richet (quoted by Le Dentu) reports a perinephritis following a blow in the flank; when he opened the abscess he recognized and removed several calculi from the kidney. Morris (*loc. cit.*, page 221) reports a similar case. He quotes another (*loc. cit.*, page 206) from Dr. Dickinson as an instance of the effect of slight repeated contusions, but in which the predisposing, or perhaps directly causative, influence of tuberculosis seems more probable: A man forty-three years old, "a free liver, and of tubercular tendency"; the cause, "the severe bruising of the loin by the rolling and tossing of the vessel during a very rough voyage from Queensland to England; two months after the perinephritic abscess was opened hæmoptysis occurred, and was followed by profuse purulent expectoration, and death in three months."

External violence presumably acts by causing larger or smaller extravasations of blood in the loose connective tissue, by rupture of vessels that are put upon the stretch either by the direct action of the violence or by the displacement of the kidney. A violent muscular effort may perhaps act in the same manner or by rupture of a portion of the muscle. The collection of blood causes irritation by its presence, which is increased by the repeated, unguarded movements of the patient, and thus a condition is created which is favorable for the development of such pyogenic germs as may chance to be lodged in the region.

The agency of chilling has long been admitted; in many of the reported cases the relation can hardly be considered as proved, but in some it appears to be sufficiently well established.

Perinephritis secondary to a general cause, such as pyæmia, septicæmia, The liver, spleen, pancreas, suprarenal capsules, and even the stomach, have either been directly invaded by the suppuration, or have softened under the influence of its proximity; the colon has been occasionally perforated.

The pus may be thin by admixture of urine, but this appears to be quite infrequent; or it may be very fetid, in consequence of proximity to the intestine; this fetidity is not an indication of perforation of the intestine.

In exceptional cases the suppuration may be of the diffuse or infiltrated form, of rapid course and grave prognosis, killing by septicæmia, or leading to the sloughing of large portions of the tissue if the patient survives.

If the inflammation is of a lower grade and chronic in its course, the tissue enveloping the kidney may become closely adherent to it and greatly thickened and hardened (Fig. 7). Morris compares it to an anatomical preparation imbedded in plaster-of-Paris.

**Symptoms.**—The beginning of the affection varies in accordance with its cause; in the primary forms it may be sudden or gradual, and in the secondary forms it is usually masked by the symptoms of the affection to which it is secondary.

One of the earliest symptoms is pain, referred more or less vaguely to the region of the kidney; it is usually dull and continuous, but may be very severe or remittent; it increases as the affection advances, and it is exacerbated by movements or by jarring and by pressure, and in some cases especially by extension of the hip, because of the implication of the psoas. It may radiate to the lower part of the abdomen, the external genitals, and the thigh, presumably through the irritation of the trunk of the nerves of the lumbar plexus.

The general symptoms are those of fever with its usual accompaniments, the fever of suppuration, with its remissions, exacerbations, and occasional chills, and its more or less marked signs of continuous or recurrent septic absorption.

Palpation carefully made by deep pressure through the anterior abdominal wall, or bimanual with one hand on the loin, reveals tenderness, and sooner or later a tumor in the region of the kidney—a tumor which is globular, smooth, elastic, and perhaps fluctuating. As the abscess grows it fills out the usual slight hollow in the loin between the ribs and the crest of the ilium, and as it approaches the surface there it makes the skin slightly œdematous, and, later, reddened and adherent.

If left to itself the pus establishes a spontaneous opening at some point, usually in the loin, which becomes the orifice of a persistent sinus, through which the abscess empties itself incompletely, with occasional periods of recurrence or exacerbation of the general symptoms excited by obstruction to the flow.

If the pus spreads in the other directions mentioned in the preceding section the symptoms will be correspondingly modified; if it descends into the iliac fossa or the pelvis, or, still more rarely, into the thigh, it will be there manifested by the usual signs and recognized by the usual manipulations. Its escape into the peritoneal cavity is followed by an acute suppurative peritonitis; its escape into the ascending or descending colon by pus in the stools and the diminution in size of the lumbar tumor. Its spread through the diaphragm and adherent lung to a bronchus leads to the sudden and violent coughing up of a large quantity of pus, and this is repeated from time to time so long as the affection lasts; sometimes the patients can bring up pus at will by bending the body in different directions. If adhesions between the lung and diaphragm fail to protect the pleural cavity from infection by the pus, an acute suppurative pleurisy follows, and usually runs a rapidly fatal course.

The *course* of the affection after the opening of the abscess differs according as it is primary or secondary. In the former case it is usually that of an ordinary phlegmon, the evacuation of the pus is immediately followed by relief of the general and local symptoms, the discharge grows steadily less, and the cavity finally closes; in the latter the affection to which the perinephritic abscess is secondary may persist and oppose the healing of the abscess, in which case the relief of the symptoms will be less marked, the improvement will not advance beyond a certain point, and it will give place from time to time to exacerbations.

Exploration of the cavity after spontaneous or surgical opening may show calculi or other foreign bodies within it or within the kidney. In one case that has remained unique the abscess appears to have opened into the stomach, and renal calculi to have been discharged through the mouth by vomiting.

In primary perinephritis, and in secondary perinephritis not of renal origin, there are rarely any symptoms connected with the urine, but sometimes the frequency of micturition is increased; in secondary perinephritis of renal origin the urinary symptoms are those of the original cause.

Among the rarer symptoms are albuminuria transient or persistent, pain or anæsthesia in the hypogastrium, scrotum, vulva, or thigh, jaundice when the affection is on the right side, and persistent flexion of the hip, simulating hip-joint disease. Gibney has called attention in several articles to the close resemblance in a number of cases, on superficial examination, to hip-joint disease, because of the immobility of the hip in flexion, the lordosis, and sometimes even pain in the knee.

**Diagnosis.**—A positive diagnosis of perinephritis can hardly be made before sufficient pus has formed to constitute a distinct tumor recognizable by palpation. The signs which precede that condition may the eruptive fevers, has nothing but the accident of its situation to distinguish it from other abscesses complicating the same general diseases. It is claimed to appear with special frequency as a complication of puerperal fever, but probably some of the abscesses that have been opened in that region in puerperal women have not originated there, but have spread upward to it from the neighborhood of the uterus or tubes.

The most frequent cause is undoubtedly that of the last group in the table: an inflammation in a neighboring organ, almost always the kidney, which either spreads to the fatty capsule and there ends in suppuration, or produces an abscess at the original site which ruptures into the loose tissue of the fatty capsule. The modes in which perinephritis can be caused by a calculus in the kidney, or by tuberculosis of the kidney, or in the course of an ascending pyelonephritis, have been already described. The other organs in which the suppurative process appears most frequently to originate are the gall bladder and the ascending or descending colon. Biliary calculi occasionally perforate the bladder, and, working backward and downward under the protection of peritoneal adhesions, reach the neighborhood of the kidney and cause an abscess in the loin. The colon may be perforated by a simple or specific ulceration, perhaps as an incident in the evolution of a carcinoma, the perforation taking place directly into the tissue enveloping the kidney between the layers of the meso-colon or through opposing and adherent peritoneal layers. Pus coming from the diseased body of a vertebra may easily make its way into and remain in the same region, and it seems not improbable that some of the perinephritic abscesses of unknown origin, and some that have been attributed to cold or to slight traumatisms, were simply cold abscesses originating in a tubercular process in a vertebra.

**Pathology.**—The loose cellular tissue in which the kidney lies is situated almost wholly behind, while in front the kidney is rather closely attached to the peritonæum and the thin intermediate fibro-cellular layer known as the fascia propria. In this posterior layer adipose tissue begins to form at about the age of ten years, but the anterior layer is usually free from it throughout life. Inferiorly the loose tissue is directly continuous with the retroperitoneal tissue of the iliac fossa and the pelvis, and posteriorly it is in communication with the different layers of the abdominal wall by the connective-tissue envelope of the vessels. Superiorly it appears to have equally free relations with the connective tissue between the peritonæum and the diaphragm. As the result of these anatomical conditions pus forming within this layer can spread with great ease upward, downward, or backward if a barrier is not formed by the condensation, the matting together, of the tissue. It forms behind the kidney, very rarely in front, and may form a single small abscess, but ordinarily, if a little time is given it, it invades the entire area and forms a collection that is bounded posteriorly by the abdominal wall, above by the diaphragm, and in front by the thickened peritonæum; inferiorly the limit is variable. A very few cases of small circumscribed abscesses have been reported.

Posteriorly the pus may make its way through the fascia by following the vessels and other lines of least resistance and become subcutaneous. It is not very rare to see quite a large subcutaneous collection that communicates with a deeper one through a small opening in the wall close above the crest of the ilium.

Inferiorly the pus may burrow close beneath the peritonæum and collect above Poupart's ligament, or it may get beneath the iliac fascia and follow the psoas into the thigh; or it may turn aside into the cavity of the true pelvis, still keeping beneath the peritonæum.

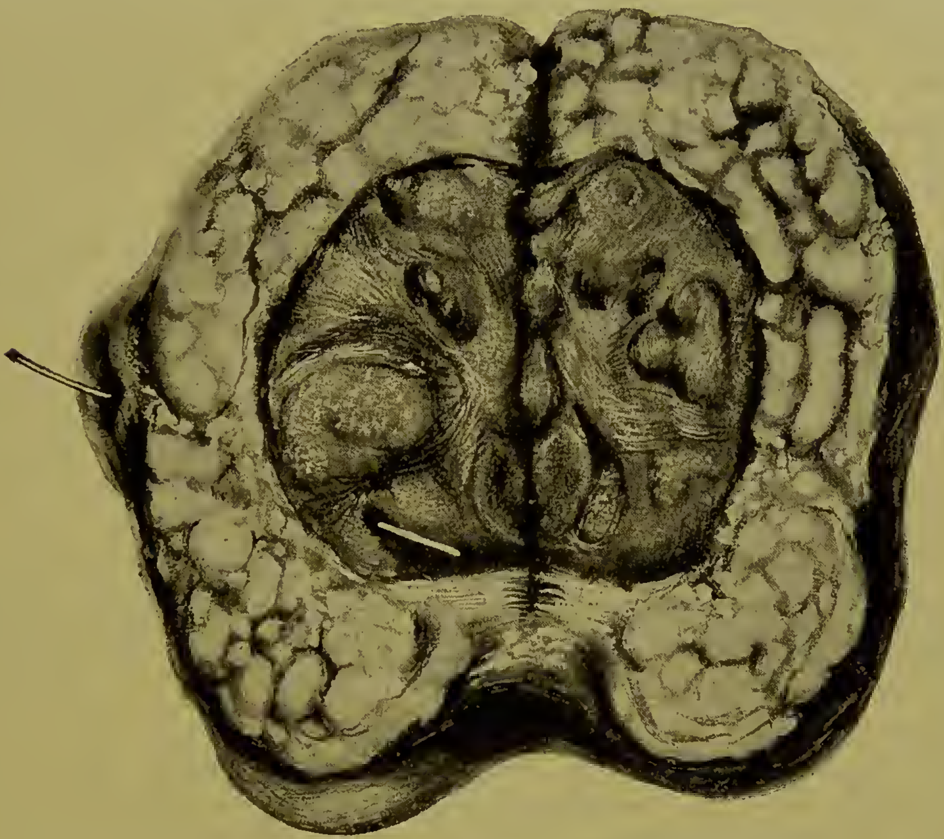

Fig. 7.—Perinephritis. (Morris.)

Superiorly the pus may perforate the diaphragm, either directly or by following the psoas upward under the ligamentum arcuatum, make its way into the adherent lung, and ultimately escape through the bronchial tubes; or, more rarely, on perforating the diaphragm it may escape into the free pleural cavity and set up a suppurative pleurisy.

Perforation of the peritonæum and escape of the pus into the peritoneal cavity is very rare.

be sufficiently marked and significant to justify a strong suspicion, or they may be so vague, or so masked by those of the primary cause, as not even to suggest perinephritis. The early symptoms are local pain and fever in combination; either without the other (except perhaps at the very beginning) could hardly be said to justify even a suspicion. The danger of overlooking the affection is apparently greatest when the fever is high, the general symptoms correspondingly marked, and the pain moderate, diffuse, or not clearly described. If a case is not thoroughly examined, perinephritis may easily be confounded with a variety of diseases, as can most others; but when the tumor in the region of the kidney can be felt, the signs that indicate the presence of pus, and of pus behind the peritonæum, can usually either be found, or can be positively declared to be absent. The change in the outline of the loin, subcutaneous œdema, possibly fluctuation, and, above all, the exploring needle, give very positive indications. A previous history of inflammatory or painful affections of the kidney is always suggestive.

Solid tumors of the kidney are differentiated by their consistency, by their more anterior position and the absence of implication of the posterior abdominal wall, and by the absence of fever. Hydronephrosis and kidney cysts have the same situation as solid tumors, and the exploring needle (introduced, of course, from behind) shows the character of the contents. With pyonephrosis an error may easily be made if puncture is employed, but it could hardly have serious consequences; and, moreover, the signs furnished by the urine and history should help to avoid it.

After the presence of an abscess has been recognized, its character and its origin may still remain in doubt. As has been said, the majority originate in and about the kidney, but they may come from the liver, the colon, or the spinal column, from the pelvis or the appendix below, and even, as in three cases quoted by Duplay (Pathol. externe, vol. v, page 779), from the pleural cavity. The differential diagnosis must be made, if at all, by the aid of the history and of associated symptoms. Dr. J. B. Roberts (Am. Jour. Med. Sc., April, 1883) has made an interesting analysis of the signs by which the position of the abscess with reference to the kidney may be indicated.

**Prognosis.**—The prognosis, which should always be guarded, varies with the cause, the course, and the treatment. Of 28 cases collected by Poland (Brit. and For. Med.-Chir. Rev., 1871, vol. ii), thought to be primary, 20 were treated by free incision (15) or by puncture with trocar (3), or opening with caustic (2), with 2 deaths; of the 8 not operated upon, 6 died. Of 10 cases of secondary abscess, 3 were opened, and the patients recovered; the other 7 died.

The prognosis appears to be graver in secondary than in primary cases, evidently because of the persistence of the cause; it is also grave in those which occur in the course of some general febrile disease.

**Treatment.**—It is claimed that attacks have been cut short, that resolution has been obtained by leeching, cupping, hot baths, and local fomentations, but the diagnosis in such cases must always remain in some doubt. The indications in the early stage are wholly symptomatic—to relieve pain and diminish the fever.

In the later stage, when the presence of pus is recognized, the indication to evacuate it is peremptory, and this is best done by a free incision in the loin. Indeed, it may be proper to make the incision even if the presence of pus is only suspected, and if an exploratory incision seems safer or more likely to yield positive results than exploratory puncture. The graver the general symptoms, the more urgent is the incision.

The incision should be large enough not merely to provide free escape for the pus, but also to permit thorough exploration of the cavity of the abscess for the detection and, if possible, the removal of the primary cause if the abscess is secondary. It may be longitudinal, transverse, or oblique, and should include division of the outer fibers of the quadratus lumborum, if the abscess is deep, both to favor exploration and to insure that the flow of pus shall long be unimpeded. The only objection to a long, transverse incision is the possibility of a subsequent hernia in the cicatrix; this has happened in one or two cases, but the contingency seems remote.

If the pus is fetid the cavity of the abscess may be irrigated with an antiseptic solution; in any case, it should be drained and lightly packed with iodoform gauze, and care should be taken, as always, that deep healing should be complete before the opening in the skin is allowed to close.

## V. RENAL AND PERINEPHRITIC FISTULÆ.

The various suppurative processes which originate within or about the kidney lead, as has been shown, to the formation of abscesses, which, after having opened spontaneously at one or another point, or having been opened by the surgeon, may leave a permanent fistulous communication with the exterior or with some mucous canal. When this fistulous track communicates with the interior of the kidney, it is known as a *renal fistula*; or, if urine escapes through it, as a *urinary fistula*; if it terminates in a blind end near the kidney, it is a *perinephritic* fistula (or sinus). Of course, the distinction can not always be made during life.

As a fistula is simply the undue persistence of an opening which is necessary to the healing of a pre-existing suppuration, the cause of a fistula is usually that which maintains the suppuration, and thus causes a constant or intermittent flow of pus through the fistulous track. Among the commonest of these causes are calculi and tubercular foci; among others are foreign bodies introduced from without, and obstruction to the flow of urine through the ureter, in consequence of which the urine is diverted into the fistulous track and keeps it open. Traumatic fistulæ are rare, and, as will appear in the examination of the results of operation upon the kidney, wounds which involve the parenchyma of the kidney have a well-marked tendency to complete healing, while those of the pelvis are much more likely to leave a fistula.

Irregularity and rigidity of the wall of the abscess, as in extreme cases of pyelonephritis, favor the persistence of a fistula by opposing the obliteration of the cavity, and this fact makes the results of late operations less satisfactory than those of earlier ones. The statistics quoted in the preceding chapter show how frequently nephrotomy is followed by fistula.

If the fistula opens upon the surface of the body the opening is in the great majority of cases in the loin; but, as has been stated in the preceding chapters, the opening may be in the groin, the perinæum, or the thigh.

Fistulæ opening into the intestines—*intestino renal*—are not very uncommon. In almost all of them the communication has been with the colon, but in a few with the duodenum, or possibly some other portion of the small intestine. The diagnosis of communication with the duodenum has been confirmed by autopsy in one or two cases, and in a few others the clinical evidence has been satisfactory, but in other supposed cases the patients have practiced a fraud upon their attendants.

Fistulæ communicating with the stomach—*gastro-renal*—have been diagnosticated in a few cases, and proved by autopsy in at least one, that of Morris (*loc. cit.*, page 261), in which the communication was between the left kidney and the greater curvature of the stomach. In a case reported by Chadwick to the Obstetrical Society of Boston (Boston Med. and Surg. Jour., Sept. 18, 1884, page 274), the patient, a lady sixty-two years of age, had had attacks of vomiting and gastric pain at intervals of from one to six weeks for seven years, and her urine contained particles of undigested food. It was believed that the communication was between the kidney and the stomach. In some alleged cases the vomited matter appeared to contain urine, and in one the patient is said to have vomited renal calculi.

The escape of urine or pus from the kidney into the peritoneal cavity is usually fatal within a very short time; but there are a few cases on record in which life has been prolonged sufficiently to make it proper to term the opening a fistula.

Fistulous communication with the lung and bronchi, or with the pleural cavity, and even through the latter with the exterior, has been noted in a number of cases.

**Symptoms.**—When the fistulous opening is in the loin the discharge may be slight or profuse, constant or intermittent, and may or may not be mingled with urine. The presence of urine may be indicated by the odor or by the special chemical reactions of some of its constituents, or by the detection in the discharge of some substance administered by the mouth to be eliminated through the kidneys—iodide of potassium, for example, which will give a blue stain to starched cloths wet with the discharge.

Traumatic fistulæ tend to ultimate, even if long delayed, healing, unless a foreign body has been left in the wound; it is not uncommon for other fistulæ to close and reopen frequently. It must be remembered that not all urinary fistulæ in the loin communicate directly with the kidney; the deep communication may be with the ureter, or the bladder, or even the urethra (Desault).

In the case of fistulæ which open internally, the symptoms are the constant or intermittent discharge of pus, possibly mingled with urine, by the corresponding channel, and the formation or increase of a lumbar tumor when the discharge is arrested, and its diminution when the discharge is resumed. Chadwick's case shows that such a communication with the alimentary canal can exist for years without seriously interfering with the general health; but ordinarily the general symptoms are important—fever, chills, inappetence, and loss of strength.

The recognition of the renal (or at least of the urinary) origin is very easy when urine is discharged through the fistula, no matter where the external opening may be, but in other cases it may be difficult or impossible, and depends mainly upon the history and upon the presence or absence of associated symptoms connected with the urine passed through the natural channels. For example, a history of nephrolithiasis, of pyelitis, of tuberculosis, and the occasional or constant presence of pus in the urine not otherwise accounted for, indicate a renal origin for the fistula.

**Treatment.**—When the fistula is maintained by the presence of a foreign body or calculus, the removal of the latter is necessary; but even this is not always sufficient, for, as has been already explained, the rigidity and irregularity of the sides of the abscess may be such as to delay or wholly prevent their approximation and union. Little is to be expected from the use of stimulating injections; occasionally persistence with them is followed by the closing of the fistula, but it is by no means clear whether this is a coincidence or an effect. In tubercular cases the persistent use of iodoform in glycerin is beneficial, and in simple suppuration much may be gained by the use of pure carbolic acid and the aseptic blood-clot.

Operative methods consist of incisions to facilitate drainage and of the removal of the kidney—nephrectomy. Occasionally it may be necessary to remove a calculus or a fibrinous plug from the ureter, and thus turn the urine aside from the fistula. Recent experience, which has shown the readiness with which wounds of the renal parenchyma heal, suggests that possibly the healing of an opening in the pelvis of the kidney might be facilitated by making another through the parenchyma into the pelvis, and that the latter would then heal notwithstanding the flow of urine through it. Thorough scraping of the wall and removal of rigid septa, spurs, and bands, are necessary adjuncts of the operations that seek to heal by favoring free drainage.

Nephrectomy has been done in a number of cases, and is a justifiable operation if there is reason to believe that the kidney is not necessary to the continuance of the patient's life.

In the case of fistula opening into the cavity of some viscus—intestine, stomach, lung—if the symptoms are urgent, it will be proper to seek to turn the flow of pus aside by an incision (nephrotomy) in the loin, and eventually to remove the kidney, if the former plan does not prove sufficient.

## VI. HYDRONEPHROSIS.

The term *hydronephrosis* was created by Rayer to designate the distention of the pelvis and calices by urine more or less changed. The condition is, therefore, to be differentiated from pyonephrosis, in which there is a similar distention with purulent contents, and from cysts of the kidney, the contents of which are watery but not urinous. Terrier and Baudouin, in an elaborate article (Revue de chirurgie, 1891, page 719) on "intermittent hydronephrosis," give a definition which contains an important pathogenic suggestion, namely, that it is "an *aseptic* dilatation of the pelvis by urine, the flow of which is obstructed by some mechanical obstacle." If infection takes place, usually from below upward, the liquid becomes purulent, and the hydronephrosis is transformed into a pyonephrosis.

Experimental ligation of the ureter has shown that its complete aseptic occlusion does not produce the dilatation of the pelvis and the sacculation and atrophy of the kidney that are found in well-marked cases of hydronephrosis. The increase of pressure within the kidney by the retained urine promptly arrests the secretion of urine, and the process does not go on to marked dilatation. On the other hand, complete temporary obstruction does produce a certain degree of dilatation; and a series of symptoms, among which pain is prominent, which have long been attributed to other causes—abnormal mobility of the kidney, for example—are now coming to be looked upon as dependent upon such temporary obstruction, and the condition is classed as an intermittent hydronephrosis, thus enlarging the series of changes to which the term is applied by inclusion of these cases of simple temporary obstruction.

The statistics of autopsies published by Morris show a frequency much greater than clinical experience would indicate. Thus, in the records of 2,610 autopsies made at the Middlesex Hospital between 1873 and 1883, he found 142 cases of marked hydronephrosis, in all of which "there was very advanced change in the kidney." Terrier and Baudouin collected 83 cases of intermittent hydronephrosis. The affection is nearly twice as frequent in females as in males.

**Etiology.**—The *cause*, which is always some obstacle to the flow of urine, may be situated in the ureter, bladder, or even the urethra, and may be congenital or acquired ; but when congenital it does not always produce its effect promptly, so that a distinction must be made between a congenital hydronephrosis, one existing at birth, and a hydronephrosis having a congenital cause—a cause existing at birth, but not producing the hydronephrosis until after the lapse of some time, perhaps many years. Morris thinks that probably one third of the cases in which a palpable tumor is present have a congenital cause. Roberts's (Urinary and Renal Diseases) statistics indicate a still larger proportion—20 out of 52 cases.

The *congenital causes* are numerous and varied, and almost always involve the ureter. This tube may be imperforate, or obstructed by an anomalous branch of the renal artery, or folded upon itself from above downward, or obstructed by valvular folds of its mucous membrane or by cysts in its wall, or may have a minute vesical orifice or a very oblique communication with the pelvis. Occasionally the ureter is double, each portion draining a separate portion of the kidney, and if one is incomplete or obstructed the corresponding portion of the kidney becomes hydronephrotic. Rayer quotes a case reported by Billard, of a still-born child with imperforate urethra, and dilatation of the bladder, both ureters, and both kidneys ; and Porak (France Méd. 1885, page 1441) attributed the enormous dilatation of the bladder (a liter), the ureters, and kidneys which he found in a still-born child to "a valve situated in the membranous portion of the urethra." Phimosis has also been alleged as a cause.

The congenital origin of the valvular folds noted in several cases has been questioned, and the folds or kinks in the upper portion of the urethra have also been interpreted as secondary to a congenital abnormal mobility of the kidney, which permitted it to sink somewhat in the abdomen and thus fold the ureter upon itself. So, too, the oblique angle of communication between the pelvis and ureter found in some cases has been claimed to be the result and not the cause of the unsymmetrical distention of the lower part of the pelvis.

The apparent contradiction between the intra-uterine production of a hydronephrosis by total obstruction of the ureter and the impossibility of thus producing it after birth, is explained by the difference in the physiological activity of the kidney at the two periods; during intra-uterine life the secretion of urine is slow and scanty, and the obstruction does not at once produce, as it does after birth, an intrarenal pressure that arrests the secretion, but the pelvis has time to dilate and thus keep the pressure for some time below the point at which the physiological activity is arrested.

The *acquired, non-congenital, causes* are still more numerous and varied. A rather common one is a calculus lodged in the ureter; others involving the ureter are clots, hydatids, or papillomatous growths within it, traumatic narrowing, twists, pressure upon it by inflammatory exudates, abdominal tumors, or the displaced uterus, and pressure upon the vesical orifice by growths within the bladder; those involving the bladder are mainly prostatic enlargements; and, finally, there are those which obstruct the urethra.

Morris groups his 142 cases above mentioned as follows: 1. Cancer of the pelvic organs—uterus, vagina, bladder, or rectum—in 116 cases. 2. Cancer of one or both ovaries in 2 cases; of these, 94 were double, 17 affected the right kidney only, and 7 the left kidney only. 3. Of the remaining 24 cases the cause was: unknown, 4; cystitis, 3; vesical calculus, 3; villous growth of bladder, 1; enlarged prostate, 3; ovarian cysts, 4; constriction of ureter, 3; pressure on ureter by abdominal cancer, 3. Of these, 12 were double; 9 affected the right kidney only, and 3 the left kidney only. He adds that, of the 32 cases recorded by Roberts, the cause was impaction of a calculus in the ureter in 11, and was supposed to be that in 3 others; in 5 there was a narrowing or obliteration of the ureter near one or the other end, presumably due to inflammation or ulceration; in 6 the ureter had been compressed by pelvic tumors, and in 3 by peritoneal inflammatory bands. Simon thinks calculus in the ureter the most frequent cause.

Exceptional causes observed or quoted by Morris are abscesses about the lower part of the ureter, enlarged lymphatic glands pressing upon it, abscess of the bladder following lateral lithotomy, obstruction of the ureter by the dragging upon it of a sacculus of the bladder, retroflexion of the uterus, and contraction of the bladder.

Whether hydronephrosis of a portion of a kidney alone is possible, exclusive of the cases of double ureter and corresponding segmentation of the kidney, has not yet been satisfactorily determined. Le Dentu refers to a case (Fenger) in which "the upper part of the kidney was transformed into a vast cavity containing urine; the pouch represented a single distended calix, the orifice of which was obstructed by a valve.

**Pathology.**—The typical changes consist in a dilatation of the pelvis and calices, and a stretching, thinning, and atrophy of the parenchyma, so that together they form an irregular sac, with translucent lobules separated by fibrous tracts showing on the surface. In the first stage (Fig. 8) the parenchyma is clearly recognizable as a thick layer capping the distended pelvis at its upper and outer part, but in the second (complete) stage (Fig. 9) nothing remains of it but a few scattered patches in the wall. When laid open, the interior shows incomplete septa limiting diverticula or pouches that correspond to the lobules on the surface, and represent, in part at least, the dilated calices; these pouches communi-

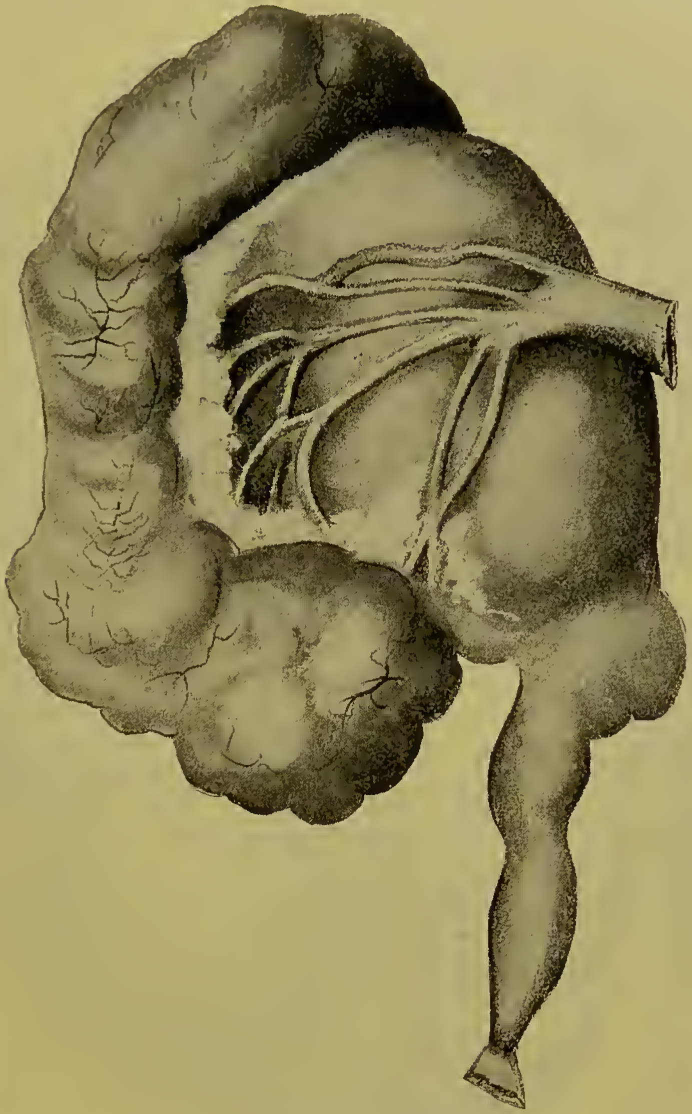

FIG. 8.—Hydronephrosis; first stage. (Le Dentu.)

cate with the main cavity of the pelvis, and possibly with the ureter, and are filled with liquid; occasionally one or more of them may be shut off from the rest by obliteration of the orifice of communication. The condition of the ureter varies according to the seat of the obstruction, being distended above it and contracted below it.

Sometimes the dilatation involves the pelvis above, leaving the parenchyma practically intact; and in some cases of double hydronephrosis the parenchyma of one kidney has appeared to be hypertrophied; probably it underwent compensatory hypertrophy while its fellow was first to become hydronephrotic, and its own subsequent implication was not sufficient to produce the usual atrophy.

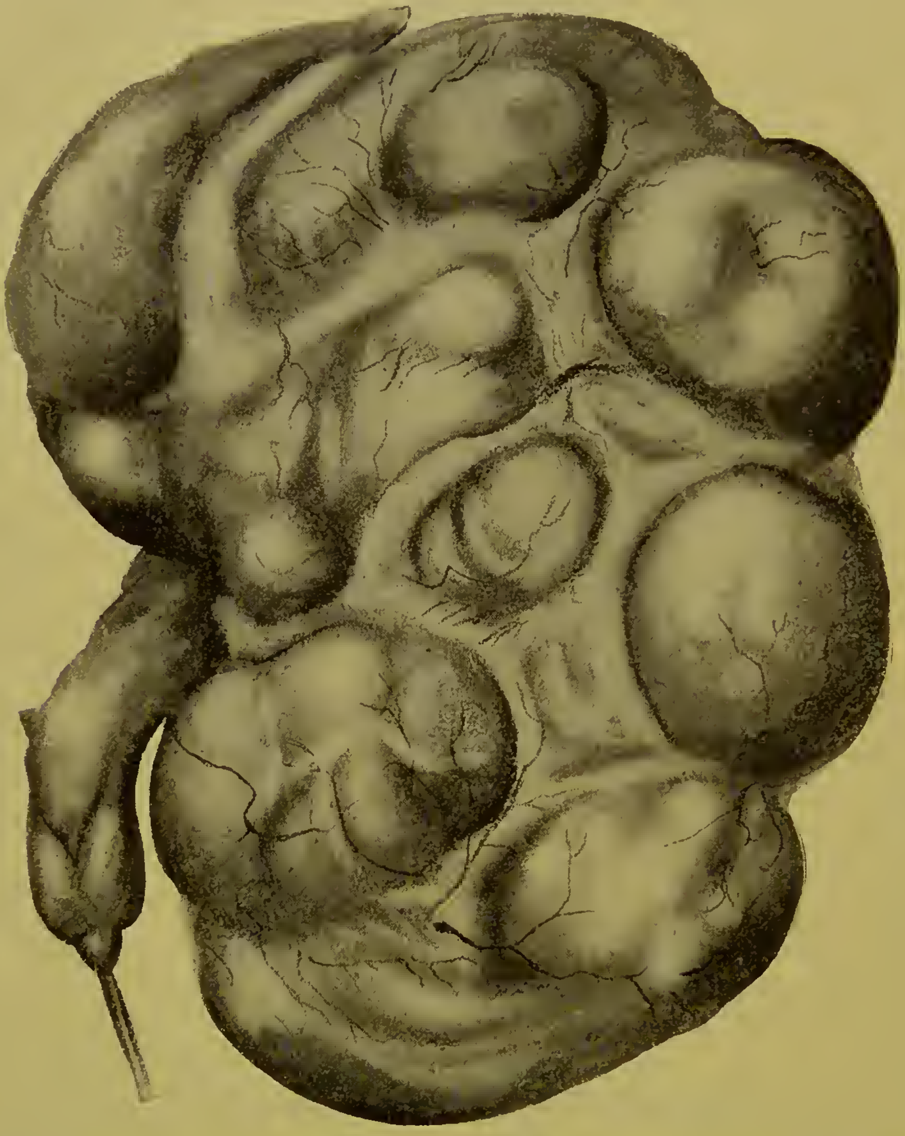

FIG. 9.—Hydronephrosis; second stage, the kidney substance being completely atrophied. (Le Dentu.)

The wall, instead of being thin and translucent as just described, may be thick and opaque. Morris says fibro-cartilaginous nodules have been found in some.

The size of the sac may be less than that of a normal kidney, or it may be so large that the tumor occupies a considerable portion of the abdominal cavity, and may even resemble a very large ovarian cyst. In some of the congenital cases the tumor has been so large that it interfered seriously with delivery.

The composition of the contained liquid varies with the degree of atrophy of the parenchyma, the completeness of the obstruction to its escape, and with other chance conditions. So long as the kidney continues to secrete urine, the liquid will contain the urea, uric acid, and the other constituents of normal urine in larger or smaller proportions; and if the interference with its escape is not complete, the liquid is usually nearly normal urine of low specific gravity and neutral or alkaline reaction. When the obstruction is complete and the kidney ceases to excrete urine, the liquid already present in the pouch undergoes change by the gradual absorption of the urinary constituents held in solution, and tends to assume the character of the contents of simple cysts, showing more or less albumen, epithelial cells, and possibly blood. Exceptionally, the contents are colloidal (Dumreicher), and in one case cholesterine was found (Coghill). In another (Terrier), one of the subordinate pouches was shut off from the rest and contained pus. Sometimes the liquid is turbid, and contains mucus, pus, or blood. If infection takes place the contents become purulent (suppurative hydronephrosis).

The amount of liquid varies from a few ounces to several gallons—thirty in Glass's case, quoted by Rayer; and in several cases in which a fistula has been established by operation it has yielded several ounces of nearly normal urine daily.

**Symptoms.**—These vary greatly, in accordance with the size of the tumor, the cause and character of the obstruction, and the degree of atrophy of the kidney. The evolution may be so quiet and arrest of growth may come so soon, that the existence of the affection will be betrayed by no symptom during life, and it will be discovered only at the autopsy. On the other hand, the symptoms associated with the cause—lodgment of a calculus, for example—may be so severe as wholly to mask those which arise from the hydronephrosis. Of the 142 cases collected by Morris from the post-mortem records of the Middlesex Hospital, "an abdominal tumor was clinically observed in but very few"; and of 42 cases of well-marked non-congenital hydronephrosis, which he quotes from Roberts, "there was a palpable tumor in 25, and in 19 of these the tumor was unilateral, in 6 double." Probably, if the condition was suspected and an examination made with the aid of anæsthesia, the presence of the tumor would be recognized in most cases.

The symptoms of the onset are usually vague, and consist of dull pain in the loin, and possibly frequent micturition and diminution in the amount of urine. If the tumor is sufficiently large, pressure-effects, especially upon the colon, may be noted.

When a recognizable tumor exists it occupies the region of the kidney, can be felt at first in front by pressure through the anterior abdominal wall, and afterward may bulge distinctly in the loin. It is flat on percussion, the colon being displaced first forward and then inward, and is usually fluctuating. It may be smooth and globular or irregular. As it grows it spreads to and beyond the median line and downward into the iliac fossa. Morris quotes Dickinson's estimate, that "in about one fourth of the cases of single hydronephrosis in which a swelling is observed during life the tumor extended beyond the median line of the body, and that in one third of these it has at length occupied the greater part of the belly." In Glass's case, above mentioned, much the largest on record, the patient was a tall woman, twenty-two years old. The belly, measured after death, was six feet four inches in circumference, and a little more than four feet from the ensiform cartilage to the symphysis pubis. The cyst contained thirty gallons of liquid; the heart was pushed up to the clavicle, and the lungs were reduced by pressure to the size of those of a new-born child. In Terrier's case the circumference at the umbilicus was one metre, and the distance from the ensiform to the pubes thirty-nine centimetres.

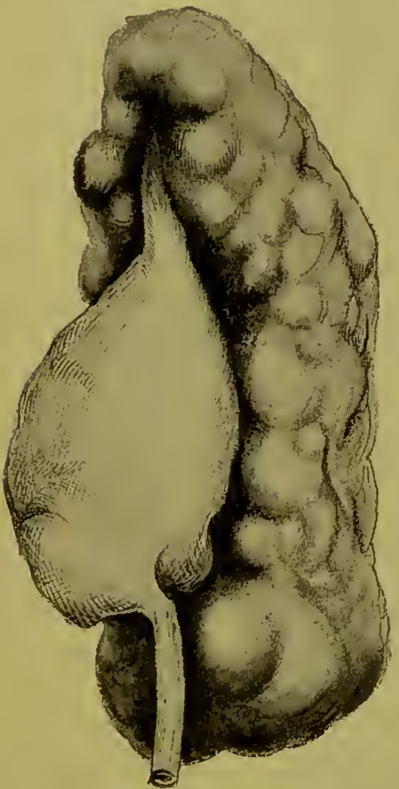

Fig. 10.—Hydronephrotic right kidney; posterior view. The mode of termination of the ureter is seen in the figure. (Revue de Chirurgie.)

The increase in size, especially if it is rapid, may be accompanied by severe paroxysmal pain.

Sudden diminution in size, coincident with the evacuation of an unusual amount of urine, is not very uncommon, and is characteristic of "*intermittent hydronephrosis.*" The name was given to the affection by Cole in 1874, and was established by an important paper published by Morris in 1876. This form of the affection has received much attention of late, especially from Landau and Israel in Germany, and Terrier and Baudouin in France, whose paper has already been quoted. The latter authors consider the form a frequent one, and believe it often to be the first stage of a permanent (or "closed") hydronephrosis. They consider abnormal mobility of the kidney to be a frequent cause of it by producing a sharp bend in the upper portion of the ureter (Figs. 10 and 11). This arrests the passage of the urine and produces a temporary hydronephrosis, which is relieved by the return of the kidney to its place. Repetition of the occurrence leads to structural irritation and to fibrous adhesions which bind the sac to the upper part of the ureter and ultimately make the obstruction permanent.

The occurrences are marked by violent attacks of pain, the appearance of a tense tumor in the flank, and diminution of the amount of urine passed. Each attack lasts several hours, and ends suddenly, rather closely resembling an attack of renal colic. I recall such an attack, supposed to be due to a calculus, that was instantly relieved by inversion of the patient. Subsequent exploration through an incision showed a marked bend in the ureter, and no calculus.

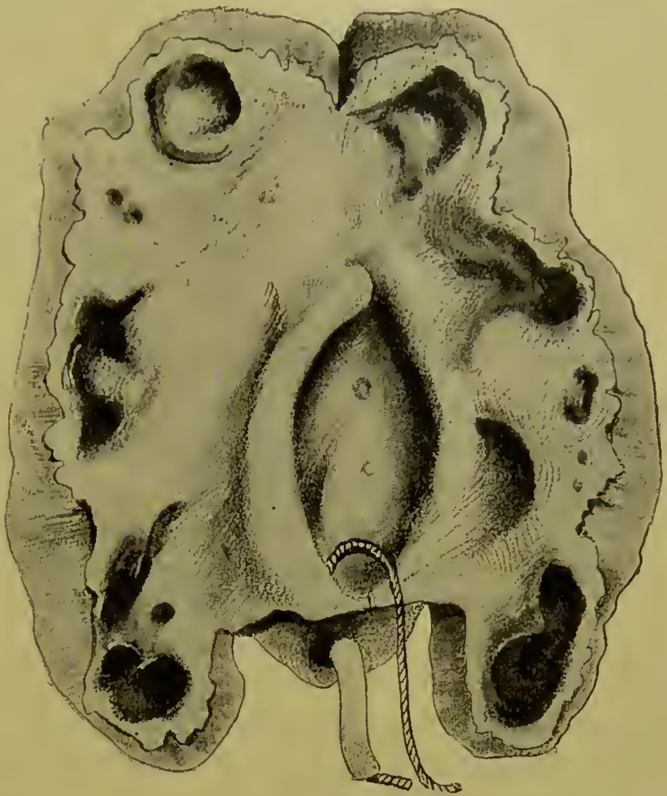

Fig. 11.—Hydronephrotic right kidney opened on its outer edge. Its anterior half is to the right; thread is passed into the ureter. (Revue de Chiurgie.)

**Prognosis.**—The cause and prognosis vary in accordance with the changes that have been described. The affection may remain stationary and even unrecognized for years; it may grow rapidly, causing intense pain and various pressure-effects upon other causes, and may even rupture into the peritoneal cavity; or, if double, it may cause death, with the symptoms known as uræmia, by the gradual destruction of the kidneys. In a few cases of intermittent hydronephrosis spontaneous cure has taken place. The prognosis is grave because of the tendency of the affection to produce complete arrest of the physiological action of the kidney, and also in many cases because of the gravity of the primary cause, such as abdominal cancer or obstructive cystitis.

**Diagnosis.**—The diagnosis, which is very difficult or impossible at the beginning, may become easy when a recognizable fluctuating and not too large tumor has formed. The position of the tumor, its close relations with the posterior wall, the presence of the colon or small intestine in front, show its real character, and it then remains only to distinguish it from other liquid collections within or about the kidney. The history will sometimes throw light upon it, and if it shows that the tumor has at some time suddenly diminished in size coincidently with the voiding of a large amount of urine, the diagnosis can be confidently made. Le Dentu gives two signs of diagnostic importance: first, that a hydronephrosis is more distinctly fluctuating than any other variety of renal cyst; and, second, that no solid mass can be felt at any point in it. Exploratory puncture in the loin may make the diagnosis by yielding a liquid that contains urea or uric acid; but, as we have seen, in cases that have existed for some time, the solid constituents are likely to have disappeared by absorption, and then the liquid yielded by the puncture is similar to that found in many other simple cysts.

When the tumor is very large it is likely to be mistaken for an ovarian cyst. Morris states that of twelve cases, in women, which he collected in 1876, seven had been diagnosticated as cysts of the ovary, and five of them had been subjected to laparotomy.

**Treatment.**—The ideal method of treatment—removal of the obstacle and re-establishment of the flow of urine—is one that can not often be carried out. Morris quotes three cases in which massage of the abdomen was followed by the more or less sudden disappearance of the tumor. In one or two acute cases, lodgment of a calculus or a fibrinous plug in the ureter, the occluding body has been removed through an incision in the loin; and it is now believed that a calculus lodged in the lower part of the ureter may possibly be recognized and safely removed through the vagina. Where the hydronephrosis is caused by pressure upon the ureter of a misplaced uterus or an abdominal tumor, the causal indication is clearly to be followed if the primary disease is suitable for operation.

Intermittent hydronephrosis, simulating kidney colic, and due to displacement of the kidney, may be temporarily relieved by inversion of the patient, or by such manipulation of the kidney as will straighten the ureter, and may be permanently cured by an operation for fixation of the kidney—nephropexy, nephrorrhaphy.

If the affection is *double* and progressive and the tumor fairly large, the plan of treatment is clear: one or both sacs should be opened by incision in the loin (nephrotomy) and a permanent fistula established. Inconvenient as such a condition may be, it is the only one that holds out a hope of arresting the destruction of the kidneys and preserving the patient's life. Possibly aspiration of the liquid would in some cases permit re-establishment of the patency of the ureter, and it may therefore properly be tried; but if reaccumulation follows, nephrotomy should be done. Such aspiration should be done in the loin, not through the peritoneal cavity.

If the hydronephrosis is *unilateral* and progressive and the tumor not very large, and if the symptoms are urgent, or if the case has been under observation long enough to make it certain that it is not of the intermittent variety, the choice of operation is between aspiration, nephrotomy, and nephrectomy. As has just been stated in the preceding paragraph, but little is to be hoped for from aspiration, and it is not wholly free from danger, so that the choice is practically between incision and extirpation Most of the few successes of single or repeated aspiration have been obtained apparently in cases in which the tumor was very large and the kidney-tissue wholly destroyed. The former, practiced in the loin, is much the simpler and less dangerous operation; it restores the kidney to some degree of functional activity, and to that extent is advantageous to the patient; on the other hand, it creates a fistula the discharge from which, and the consequent annoyance, will vary directly with the amount of kidney-tissue restored to activity. For some, the annoyance of such a fistula would outweigh the greater risks of nephrectomy and those inherent to the possession of only a single kidney, but experience has shown that it can sometimes be very satisfactorily controlled by suitable dressings even when the daily discharge amounts to ten or twelve ounces. Moreover, if the annoyance becomes intolerable, nephrectomy can still be done, and with no more risk than if it had been done primarily.

If, on the other hand, the tumor is very large, the risks attendant upon an attempt to remove it are so great that nephrectomy is hardly justifiable. More is now to be hoped for from aspiration; a number of cases thus treated have been cured; and if the operation is done judiciously, and the needle not passed through the peritonæum, the attendant risks are probably no greater than those of incision and drainage.

Incision and drainage may be made in the loin or through the peritoneal cavity; the former appears to deserve the preference, as involving less danger, although it must be admitted that with proper precautions the dangers of the transperitoneal method are slight. Le Dentu thinks the latter has an important advantage, one that dominates all other considerations, in that it gives greater facilities for satisfactory drainage. It is probably to be preferred in cases of doubtful diagnosis; and when the abdomen has been opened through an error in diagnosis, and the supposed ovarian cyst found to be a hydronephrosis, many surgeons would probably prefer to complete the operation in that way rather than to close the anterior incision and open the cyst through a second incision in the loin.

If the lumbar route is chosen, the incision should be transverse or oblique, and deepened layer by layer until the sac is reached; the latter, after evacuation of its contents through a free incision, should be stitched to the skin, and its interior explored as far as possible with the finger, with the object of opening up all pockets, detecting the presence of a calculus, and properly placing the drainage-tubes.

If the anterior—transperitoneal—route is chosen, the incision should be made with reference to easy access to the tumor and to subsequent drainage. It is assumed that the tumor is in contact with the wall at the seat of the incision. After protecting the adjoining peritonæum with sponges, a large trocar is thrust into the cyst, and as its contents escape the sac is seized with volsella forceps and drawn out through the incision; finally, the sac is incised, and the edges of the incision stitched to the skin. Drainage-tubes are then appropriately placed, and the usual dressings applied. Possibly a counter-opening for drainage in the loin would be advantageous.

After these operations, also, a secondary nephrectomy may be successfully done to close an annoying fistula.

## VII. CYSTS OF THE KIDNEY.

There are three kinds of cysts to be described: (1) simple or isolated cysts, (2) conglomerate cysts, (3) hydatid cysts. This classification is not to be deemed complete from the pathological standpoint, but it is sufficient for clinical purposes. It is not designed to include the small cysts so often found in granular kidneys, or partial hydronephrosis, the dilatation of a calyx shut off from the pelvis, which resembles a cyst much more closely than it does the common hydronephrosis.

### 1. ISOLATED CYSTS.

The term *isolated* is employed, for lack of a better, to distinguish these from *conglomerated* cysts; it signifies, not that they are always single, but that they are not grouped; that, when multiple, they are separated from one another by unchanged portions of the kidney-substance. They originate apparently in the cortex, and project beyond its surface; they occasionally attain a great size (Fig. 12), but ordinarily are not large enough to attract attention during life. Morris states that 2,610 autopsies at the Middlesex Hospital furnished 5 cysts of this kind, and 3 conglomerate cysts; the largest of the 5 was the size of a Tangerine orange, the smallest that of an olive. One patient was nineteen years old; the others forty-nine or more.

The wall is usually thin and translucent, but is sometimes thick and opaque; the contents are usually watery, with a little albumen, some salts, and occasionally traces of the specific elements of urine; sometimes the amount of albumen present is so great that heat will change the whole into a jelly-like mass, and sometimes the contents have the consistency of thin glue. Admixture of blood with the contents correspondingly changes the appearance and character. Cornil has pointed out that some specimens thought to be sanguineous cysts are actually neoplasms (epithelioma, adenoma, sarcoma) that have undergone cystic degeneration.

The pathogeny of these cysts has not been made out; they are thought to originate by dilatation of a glomerule, or of a tubule, or within the cellular tissue surrounding the vessels.

Le Dentu quotes from Lannelongue a case in which the *cyst contained gas.* The patient was eight years old; the tumor large, and occupied the right flank. Exploratory puncture yielded a pint of greenish liquid, that contained nothing that threw light upon the character of the cyst. It was then noticed that gas was present, and it was withdrawn by another puncture, and shown to consist of 8 parts of oxygen, 7 parts of nitrogen, and 1 part of carbonic acid. There was no indication of any communication with the intestine. After the child's death by some intercurrent affection, the autopsy showed that the sac was situated in the kidney, that it had recently opened into the pelvis, and that the gas had not passed down to the bladder. The origin of the gas was not ascertained.

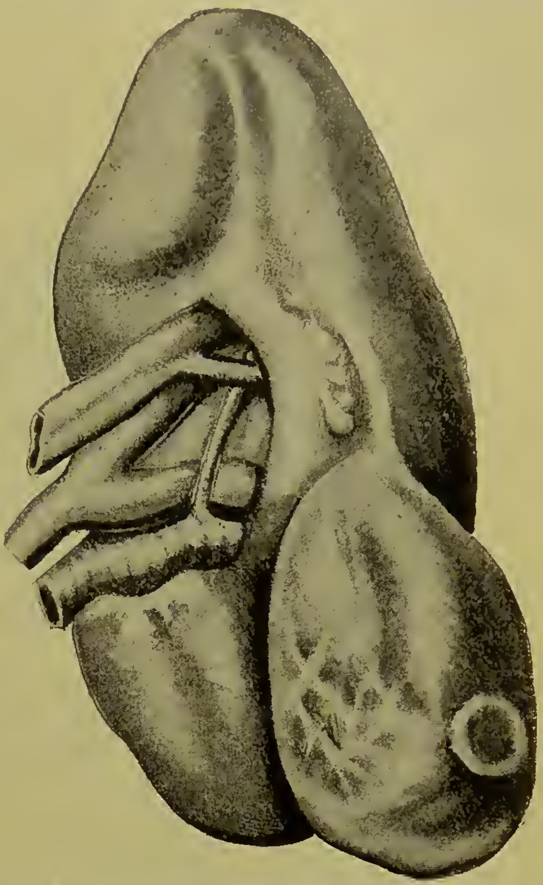

FIG. 12.—Isolated cyst of the cortex of the kidney.

*Multiple small vesicles* are occasionally found in the mucosa of the pelvis and ureter (Fig. 13); they are supposed to originate in the mucous glands.

One or two cases of *atheromatous* or *calcareous* cysts have been reported.

**Symptoms.**—A cyst gives no symptoms before it is large enough to make pressure upon adjoining viscera. When its position and size are such that it can be palpated, it will be found to be firm, elastic, and globular when of medium size, and to resemble other large cysts when large. It does not modify the urine, or the frequency of urination, except perhaps by pressure. The differential diagnosis between a serous cyst, a hydronephrosis, or a hydatid cyst, may sometimes be made by exploratory puncture, the liquid in the first place being albuminous, in the second possibly urinous, and in the third free from albumen and containing hooklets. Some of the larger cysts have been mistaken by experienced surgeons for cysts of the ovary.

**Treatment.**—As the cysts are not malignant, and as they affect the health of the patient only through their size, the propriety of interference will be determined mainly by the urgency of the pressure symptoms. The choice of operation lies between aspiration of the contents, incision and drainage, and nephrectomy. The latter, according to Le Dentu, has yielded, in 11 cases, 7 deaths and 4 cures.

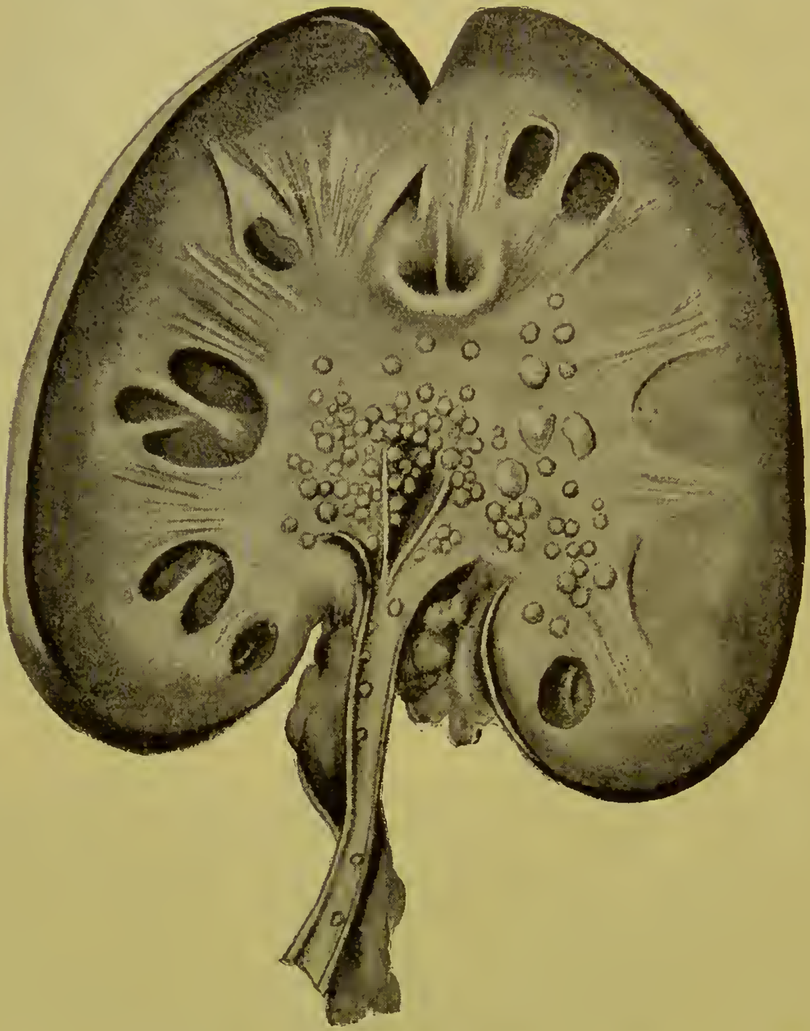

Fig. 13.—Vesicular cysts of the mucosa of the pelvis and ureter. (Le Dentu.)

Extraperitoneal aspiration in the loin is said to have cured once (Duplay). Theoretically, its dangers should not be very great, and it seems proper to employ it, and to repeat it in case the cyst refills. The risks of following it with the injection of an irritant, such as tincture of iodine, are probably considerable.

Incision with drainage in the loin is probably but little, if any, more dangerous than aspiration; the edges of the incision in the cyst should be stitched to the skin.

Incision with drainage through the peritoneal cavity, under proper protection, would not involve much more risk; and in cases in which the development of the cyst has been toward the peritoneal cavity, and not along the posterior and lateral abdominal wall, it would be the only practicable method. It is applicable only to large cysts in contact with the anterior abdominal wall. In cases in which the abdomen had been opened under the impression that the cyst was ovarian, it seems probable that most surgeons would complete the operation in this way.

Nephrectomy should be reserved for cases with special indications. Quite recently Tuffier (Arch. gén. de méd., July 1891) has successfully practiced extirpation of the cyst and reunion of the kidney parenchyma by suture.

### 2. CONGLOMERATE CYSTS, OR CYSTIC DEGENERATION, OR LARGE POLYCYSTIC KIDNEY.

A kidney thus affected is readily distinguishable from one containing multiple isolated cysts, as just described, or from one studded with the minute cysts of interstitial nephritis. Its surface is lobulated, its size often very great, its shape nearly that of a normal kidney, and on section its parenchyma is seen wholly to have given place to a multitude of closely agglomerated cysts of various sizes (Fig. 14). In Hare's case the kidney was fifteen inches long, and weighed sixteen pounds. The smallest cysts are microscopical, the largest rarely larger than a grape. Some of the larger ones appear to have been formed by the coalescence of several smaller ones, the wall showing on its inner surface the remains of the septa that previously separated them. This inner surface is covered with pavement epithelium. Of the kidney-substance, only traces can be found here and there in the larger tumors; in the smaller ones it is present in varying amount, and shows the changes of interstitial nephritis.

The contents of the cyst vary greatly in color and consistency, and are sometimes purulent, bloody, or urinous.

Usually both kidneys are involved, but unequally; and in a few cases the liver has shown a similar degeneration.

The pathogeny of the affection has not been ascertained; the principal theories suggested are obstruction of the tubules as the result of an interstitial nephritis (Virchow), or of lithiasis (Lecorché), or epithelial degeneration similar to that which leads to ovarian or testicular cystomata (Malassez). The condition is sometimes congenital, sometimes acquired, and in the latter case is most common between the ages of forty and fifty years.

**Symptoms.**—The symptoms, when any are present, are in the main some of those of Bright's disease: pain in the loins, occasional hæmaturia, the urine sometimes scanty and bloody, sometimes pale, light, albuminous, and abundant; hypertrophy of the heart. When the destruction of the kidney-tissue is sufficiently advanced uræmic symptoms appear. Occasionally the tumor is recognized on palpation.

**Diagnosis.**—The diagnosis might be made by recognition of enlargement of both kidneys with lobulation of the surface, the changes in the urine indicative of nephritis, and œdema limited to the lower limbs and dependent upon pressure made by the kidney upon the large abdominal veins.

**Prognosis and Treatment.**—The prognosis is grave, because of the inevitable ultimate destruction of the kidney, and the possibility that any almost indifferent intercurrent cause may lead to a fatal uræmic outbreak; but it is somewhat mitigated by the slow progress of the disease.

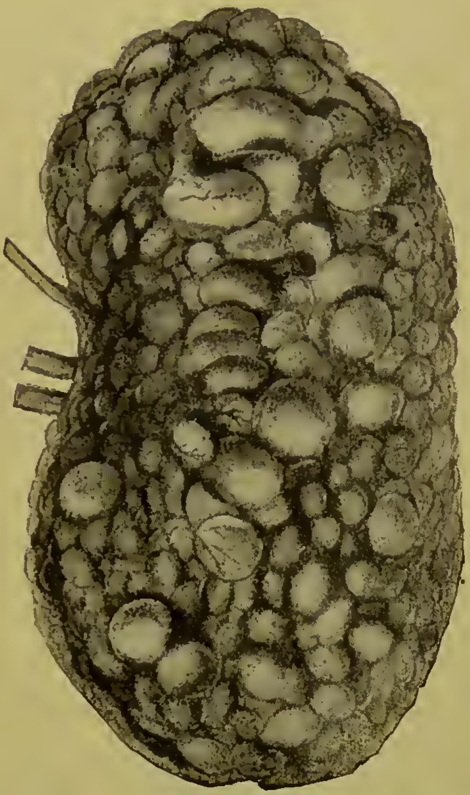

Fig. 14.—Polycystic degeneration of the kidney. (Le Dentu.)

No surgical treatment is possible if both kidneys are involved, or desirable in the exceptional cases in which only one is diseased.

### 3. HYDATID CYSTS.

Although hydatid cysts of the kidney have long been known, the first attempt to collect and analyze the scattered cases was made in 1861, by Béraud, in a graduating thesis. He collected 41 cases, 7 of which had not been published. Roberts, of Manchester, collected 63; and quite recently (1887) J. Boeckel (Étude sur les kystes hydatiques du rein) added 20 new cases to the list.

Compared with those of other organs, hydatid cysts of the kidney are rare: 30 cases in 566 collected by Davaine, 80 of 983 collected by Neisser. Béraud found the left kidney more frequently affected than the right, and, although some of the subsequent statistics have reversed this predominance, it has been re-established by the latest and largest. Occasionally, but very rarely, the other kidney or another organ is simultaneously affected.

The cyst may form immediately beneath the capsule or deep in the kidney-tissue; and it may not exceed an orange in size, or it may become very large. It shows a distinct tendency to grow toward the peritoneal cavity, and thus to drag the kidney from its place and make it abnormally movable. According to Roberts, there is a strong probability of ultimate rupture of the cyst into the pelvis of the kidney and discharge of its contents through the ureter and bladder; this was observed in 52 of the 63 cases collected by him. Rupture into the intestine has been observed in 4 cases, into the stomach in 1, into the lung in 4, and into the muscular planes of the back in 3. The cyst may suppurate, or it may shrink after death of its contents, as in hydatids of other organs. By lodgment of a fragment or of a daughter-cyst in the ureter, hydronephrosis may be caused.

**Symptoms and Diagnosis.**—A hydatid cyst gives no symptoms, unless it is large enough to make pressure upon adjoining organs or to be recognized by palpation, or unless it ruptures into some hollow viscus through which the hooklets or daughter-cysts may be evacuated. The tumor is globular, elastic, and flat on percussion. The hydatid thrill appears to be rarely recognizable; the manipulation for its detection is thus described by Newman (Surgical Diseases of the Kidneys, p. 140): "The cyst should be compressed by the second finger of the left hand, and a slight, sharp tap should be given to it with the finger of the right hand. The finger should be allowed to rest for a short time, when a peculiar vibratory thrill will be communicated to the left hand. When felt it is of great value, but its absence is of no significance. Its duration is uncertain—sometimes brief, but frequently prolonged."

Rupture into the pelvis of the kidney is followed by the symptoms of nephritic colic, and the appearance in the urine of the characteristic hooklets or cysts. This appearance in the urine, while positive evidence of the presence in the abdomen of a hydatid cyst, is not proof that the cyst occupies the kidney, for cysts of the liver may rupture into the pelvis or ureter, and a cyst developed in the connective tissue between the bladder and rectum has ruptured into the former. Rupture into the lungs is indicated by the expectoration of the characteristic elements, and rupture into the intestine by their presence in the fæces in case other circumstances lead to the necessary examination. The collapse of the cyst after rupture may be so complete that even the most careful palpation will not determine its position. Exploratory puncture of a recognizable tumor may serve to determine its character. Still, it is to be remembered that the diagnosis, both of the nature and of the character of the tumor, is extremely difficult and uncertain, and the records of published cases are full of errors. Le Dentu noticed in his cases that he could distinguish one portion of the tumor as globular and fluctuating or elastic, and an adjoining portion as solid and resembling a kidney in shape and consistency, and he thinks that a similar finding would justify the diagnosis of a hydatid cyst.

The evolution of the affection is slow, but the tendency is distinctly toward a fatal result. Of 22 cases of spontaneous rupture into the pelvis of the kidney, in which the final result is recorded, 6 appear to have been cured, in 6 the condition remained stationary, and 10 died. Of Roberts's 63 cases the ultimate result is known in 39; of these, 19 died, but it is said that in 9 of them the causes of death were unconnected with the hydatids (Morris). On the other hand, cases are recorded in which patients have continued " to pass vesicles at intervals for twenty and even thirty years." According to Morris, there is no fatal case on record in which vesicles have escaped per urethram from a renal hydatid cyst which had *not* given rise to an abdominal tumor.

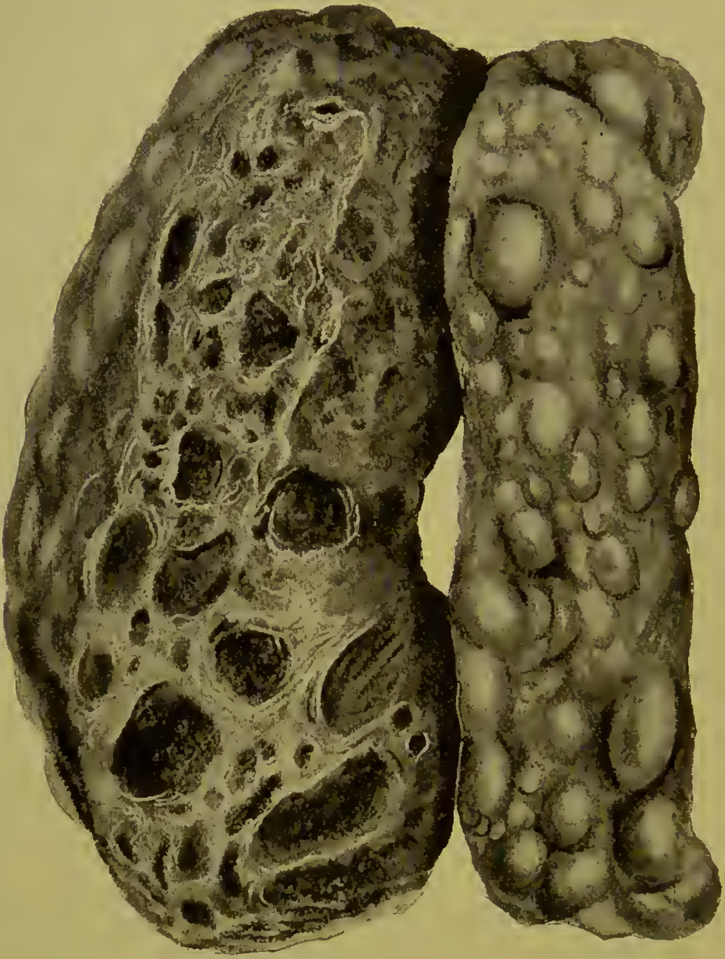

FIG. 15.—Cystic degeneration of the kidney. (Morris.)

**Treatment.**—Simple aspiration of the contents of the cyst has been followed in a few cases by an apparently permanent cure, or at least by a long period of quiescence; it is therefore entitled to a trial in any case in which the needle can be introduced without passing it through the peritoneal cavity. This failing, incision of the cyst, in the loin or through the peritoneal cavity, followed by excision of as much of the sac as can be conveniently removed, and by suture of the edge of the remainder in the parietal wound, is the method of choice, and has given excellent results.

Nephrectomy may be proper if the kidney is wholly destroyed, and if the tumor is free and movable in the abdomen.

Experience with hydatid cysts of other organs indicates that possibly the injection of a 1–1000 solution of the bichloride of mercury into the sac after evacuation of its contents, or the injection of a few grammes of the solution by a hypodermic syringe, without previous evacuation, may effect a radical cure.

## VIII. SOLID TUMORS OF THE KIDNEY.

### A. MALIGNANT TUMORS.

It will be convenient in this chapter to employ the term *cancer* as a synonym of malignant tumor, including under it the observed varieties of carcinoma, sarcoma, and lymphadenoma.

Cancer of the kidney may appear at any age, but is most frequent in infancy and in advanced life, and is more often seen in males than in females. It may be *primary* or *secondary*, the latter, according to Morris, being five times as frequent as the former—twenty-five secondary and five primary having been found in the 2,610 successive autopsies which he analyzed. Of the *secondary* cases, which, of course, are entirely beyond the resources of our art, I shall only say that they appear to be more common in females than in males, and that in Morris's 25 cases the seat of the primary disease [*carcinoma*] was the female breast in 5; the female genital organs and bladder in 4; the rectum in 2; the omentum, duodenum, and liver, 1 each; *lymphadenoma* in stomach 1, and prostate 1; *sarcoma* in arm, axilla, pleura, orbit, spinal dura, and a fibroma of the uterus, each in 1; *epithelioma* in the tongue 1, and cervical glands 1.

*Primary* cancer appears in three forms—carcinoma, sarcoma, and lymphadenoma, sarcoma occurring mainly in the young, sometimes congenital, and carcinoma in the old; lymphadenoma is very rare. Of the carcinomata, the encephaloid is the more common variety, then the melanotic; scirrhus and colloid are so rare that it is questioned if the few reported cases were correctly understood.

The common forms of sarcoma have been observed, including the myosarcoma or rhabdomyoma, which is characterized by the presence of striped and unstriped muscular fibers, and is rarely seen except in the kidney.

Until a late period in its evolution the neoplasm is confined within the capsule proper of the kidney, appearing either as a single mass, or as a number of scattered nodules varying in size from that of a pea to that of an egg, or as a general infiltration of the kidney. The capsule thickens over the growth and its veins enlarge, and ultimately it gives way and allows the tumor to appear on the surface as a cauliflower growth, or it contracts adhesions with adjoining parts, and the cancer spreads directly through it into them. On the other hand, generalization of the disease takes place promptly, affecting first the lymphatics at the hilum and the neighboring lumbar retroperitoneal glands. Roberts found generalization to have taken place in 31 cases out of 51; Dickinson in 14 out of 19; Rohrer in 50 out of 115; Ebstein in more than half; Laschmann in 26 out of 39; and Guillet in 47 out of 70. (Quoted by Chevalier, Tumeurs malignes du rein, Thèse de Paris, 1891.)

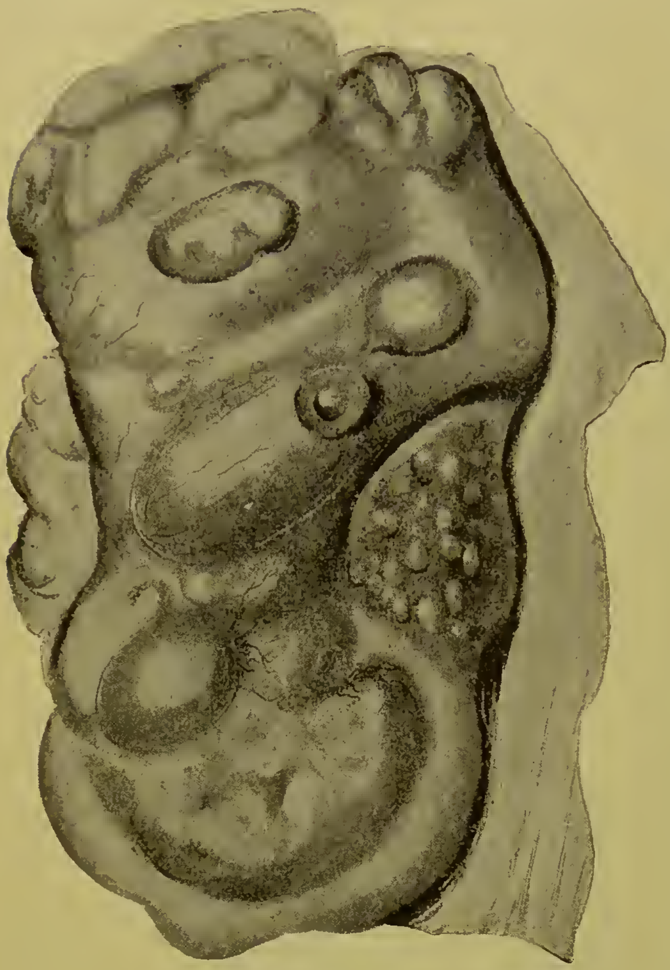

FIG. 16.—Cancer of the kidney. (Rayer.)

In the adult the size of the tumor is not often great, but in the child it may reach ten, twenty, even thirty pounds. The growth is forward toward the peritoneal cavity, and then, as its weight increases, downward; on the right it tends to pass completely to the outside of the ascending colon; on the left it is habitually crossed by the upper part of the descending colon. The tumor may compress the renal vein or the vena cava, or obstruct it more or less completely by direct growth through its wall into its lumen, and in the latter case may give rise to fatal embolism of the pulmonary artery, the embolus being either a blood-clot or a fragment from the projecting portion of the tumor. Sooner or later it spreads to the pelvis of the kidney and the ureter, or it may originate in the former in a form apparently identical with the "villous tumor" of the bladder.

**Symptoms.**—In the typical form, as presented in about half the cases in adults, the patient complains of vague pain in the lumbar region, that appears and disappears without apparent cause, and lasts for longer and shorter periods; occasionally it is sharp and paroxysmal, as in nephritic colic; at the same time he voids blood at intervals with his urine, and the amount of the bleeding, its appearance, and its cessation do not appear to be influenced by exercise or rest. The blood is uniformly mixed with the urine, but sometimes long clots are present. The frequency of micturition is not increased, and the general health may not be greatly deteriorated. A tumor may be recognizable in the flank—a rounded, firm, movable tumor. Varicocele may be present on the same side. In other cases, pain and recurrent hæmaturia exist but the tumor is absent; and in others the tumor is present and the other symptoms absent. Exceptionally, all these symptoms may be absent, and a steadily increasing cachexia may be the only indication of the disease.

The tumor, when small, may be detected by careful palpation, one hand being placed transversely against the liver, the other longitudinally upon the anterior wall, with the tips of the fingers close below the free border of the ribs. If, by steady pressure in this position, the kidney can be felt, it is to be considered enlarged or displaced. Guyon attaches much diagnostic importance to *ballottement* of the kidney, obtained while the hands are in the position just described, and moderate pressure is made by the anterior one by pressing sharply forward with the other fingers in the loin; the kidney, if enlarged, can be felt to strike against the anterior wall. Another method is to grasp the flank with one hand, the thumb in front, the fingers behind, and to press the tips of the fingers of the other hand deeply in beside the median line at and above the level of the umbilicus; the kidney can then be felt to move downward in deep inspiration.

Varicocele is so common an affection on the left side that it is significant only when on the right.

Hæmaturia occurs at irregular intervals, without recognizable cause, although sometimes it follows vigorous palpation of the kidney, and usually lasts for several days; it may cease for a few hours coincidently with colicky pain, and reappear after cessation of the pain. It is a more common symptom in adults than in children. Occasionally fragments of cancer-tissue have been voided with the urine.

Pain is ordinarily dull, but may at times be severe. Pressure upon the stomach or intestines may produce gastric symptoms, and pressure on the vena cava may cause œdema of the lower limbs.

**Diagnosis.**—The diagnosis, as to both the seat and the nature of the tumor, is full of difficulty, and the records show many mistakes made by skillful and experienced surgeons. The source of hæmaturia can usually be satisfactorily determined by the use of methods elsewhere described, and when it coexists with a recognizable tumor in the flank the renal origin of the latter may be safely assumed. The differential diagnosis from renal calculus, pyelonephritis, tuberculosis, and hydronephrosis, must be made by the absence of the groups of symptoms indicative of those affections. As between sarcoma and carcinoma, the differential diagnosis is not possible, and, indeed, is not worth making, since the clinical course is the same. The urgency of an early diagnosis is great, for it is only in the early stage of the disease that surgery can hold out any hope of a cure; for that reason an exploratory laparotomy, or lumbar incision, seems fully justifiable whenever the symptoms indicate or reasonably suggest a beginning cancer.

**Treatment.**—The only operation that can be considered, according to our present knowledge, is the removal of the tumor and the kidney—nephrectomy; and the record, which comprises more than one hundred cases, is not encouraging. Remembering the promptness with which generalization takes place, it may fairly be claimed that when the tumor is large enough to be easily recognizable through the abdominal wall its removal would not be a removal of all the disease, and that, merely as a palliative measure, without hope of a radical cure, nephrectomy is too dangerous to be undertaken. This practically excludes it in all cases occurring in children, for in them, as a rule, attention is first called to the disease by the recognition of an abdominal tumor.

In cases in which pain and hæmaturia have led to a diagnosis early in the course of the disease, nephrectomy is a justifiable although hazardous procedure. The lumbar—extraperitoneal—operation has shown a larger measure of operative successes than the transperitoneal method, and therefore would probably be preferred by most, notwithstanding certain rather important advantages that are offered by the other. With a constantly improving technique, and with earlier accurate diagnosis, it may be hoped that a larger measure of success will attend operative interference in the future.

### B. BENIGN TUMORS.

Benign tumors of the kidney seldom have any other than a pathological interest; clinical importance comes only from the size which they sometimes attain, and in certain diffuse lipomata from their compression of the kidney-tissue. The only indication for operative interference, consequently, comes from the size of the tumor; certain large fibromata and cysto-fibromata have been successfully removed by transperitoneal nephrectomy.

## IX. DISPLACED KIDNEY.—MOVABLE KIDNEY.

The kidney may congenitally occupy a position other than that in which it normally lies, one even as low as the true pelvis where it has been found behind the rectum and between the rectum and bladder. That the ectopia is congenital, is proved by the origin of its artery, at a correspondingly low point in the aorta or one of the iliac arteries, and the emptying of its vein into the nearest large venous trunk. The condition has no surgical importance except in diagnosis; it is important that it should not be mistaken for an acquired and remediable displacement.

An acquired displacement with abnormal mobility is known as *movable kidney* or *floating kidney.* These two terms are generally used interchangeably, although it is sought by some so to use them as to distinguish between two different anatomical conditions—to apply the term *movable* to those cases in which the kidney is freely movable behind the peritonæum, and the term *floating* to those in which the kidney has moved forward, away from the posterior abdominal wall, and has become completely invested by the peritonæum and has a distinct mesonephron. Although it is admitted that the two conditions can not be distinguished from each other except by direct examination, it is claimed that the surgical importance of preserving the distinction is great. As the second condition, that of complete peritoneal investment with formation of a mesonephron, is so rare that only two or three authenticated cases are on record; and as the term "floating kidney" is in almost universal use to designate the clinical condition of abnormal mobility which includes both forms, the attempt to discriminate may well be abandoned, and the two terms be used indifferently. Such a result would be in harmony with the conclusions of a committee of the London Pathological Society appointed to report on the subject.

*Acquired ectopia* (which alone will be considered in the remainder of this chapter) is developed in most cases between the ages of twenty and forty years, is very much more common in women than in men (55 to 9, Lancereaux; 82 to 14, Ebstein), and on the right side than on the left (65 to 14, Ebstein). Catamenial congestion, parturition, and tight lacing, are thought to be frequent causes; but when we reflect how common these alleged causative influences are, and how rare the condition under discussion (5 cases in 3,658 autopsies, Ebstein; 22 cases in 5,500, Rollet), we must admit the probability of some predisposing or associated cause. There is good reason to think that when there is but one kidney (congenitally) it is particularly liable to become displaced, presumably because of its greater weight.

The displaced organ appears to suffer but slight changes, if any, as the result of its displacement. It has been found congested, sometimes larger, sometimes smaller, than normal, with indications of interstitial nephritis. In the chapter on hydronephrosis mention has been made of the production of a sharp turn or kink in the upper part of the ureter by displacement of the kidney, and the consequent interference with the flow of urine.

**Symptoms.**—In a well-marked case the kidney, recognizable by its shape, size, and consistency, presents itself as a freely movable tumor at a greater or less distance below the free border of the ribs. Pressure upon it causes pain, or a peculiar sickening feeling. The patient complains of dull or sharp dragging pain in the abdomen, provoked by standing, walking, on the approach of the menstrual period, or perhaps of sharp, paroxysmal pain resembling kidney colic. With these are associated other more or less vague sensations referred to the stomach, intestines, or liver. These symptoms are generally relieved by recumbency, and sometimes by wearing a tight girdle. Pressure upward and backward upon the kidney when the patient is in dorsal decubitus causes it to disappear, or at least to become much less easily recognizable. Its independence of the liver can usually be determined by palpation and percussion, and it is to be distinguished from other renal tumors, solid or cystic, by its size, shape, consistency, and mobility. It may be confounded with stercoral accumulation in the colon, or with tumors of the mesentery or omentum Cases of slight displacement and sharp paroxysmal pain, due to obstruction of the ureter by kinking, are to be distinguished from renal calculus by the absence of blood from the urine, and by the promptness with which the pain will sometimes cease when the displacement is corrected by a change in the patient's attitude, such as raising the hips above the shoulders, or by pressure upon the kidney.

**Treatment.**—In the slight cases it may be sufficient to avoid the forms of exercise which excite the pain; in others, specially fitted and padded abdominal bandages have effectually opposed recurrence of the displacement, and enabled the patient to go about as usual. One device that has been especially recommended is the addition to such a bandage of a rubber bag, which when inflated would hold the kidney in place. Special trusses, with adjustable pads and arms, are said also to have afforded relief; but the tyranny of such dressings seems intolerable when it can be avoided, and experience has shown that it can be escaped in many cases by a simple operation that involves but little risk.

This operation—nephrorrhaphy or nephropexy—consists in exposing the kidney by an incision in the loin, drawing it back to its proper place, and fixing it there by sutures. It is urged on theoretical grounds that the operation is impracticable when a mesonephron exists; but no operation that has yet been begun has had to be abandoned on that ground, and it is not easy to see why, if that very rare condition should be encountered, the mesonephron should not be split, or even the peritonæum beside it opened, and the kidney drawn out through the opening.

An alternative operation is the removal of the kidney. That has been practiced in a considerable number of cases. Newman (*loc. cit.*, p. 62) collected 30; in 6 of them the kidney was removed through the loin, all successfully; in the remainder it was removed by laparotomy—24 cases, with 9 deaths. In one of these cases the removed kidney was the only one the patient had; she survived eleven days. In two of the 10 cases of lumbar nephrectomy collected by Brodeur the patients died. In one of them the second kidney was lacking, and in the other it was functionally incapacitated. The possibility of such a state of things, or of the other kidney being seriously diseased, and the risks inherent in the operation itself, should limit resort to nephrectomy to cases in which all other means of relief have failed, and to those in which it is indicated by the co-existence of some other disease, such as pyelonephritis or tuberculosis. That in this small number of nephrectomies the kidney should twice have been found to be the only one, shows that the chance of encountering the condition in this affection is vastly greater than it would ordinarily be. The opportunity which it affords to determine the presence or absence of the other kidney by direct palpation is the only reason for preferring transperitoneal to lumbar nephrectomy.

## X. OPERATIONS UPON THE KIDNEY.

These comprise nephrotomy, nephrolithotomy, nephrectomy, and nephrorrhaphy or nephropexy.

The kidney may be approached for exploration, incision, or removal through the loin, or through the anterior abdominal wall and across the peritoneal cavity. When the conditions that make the operation necessary are such that either route may be taken, the preference is usually given to the lumbar incision as the least dangerous; and of late it has even been so extended and combined with opening into the peritoneal cavity when necessary, that it has acquired for itself some of the advantages that have heretofore been thought to be obtainable only by the anterior incision. As the details of the incision through the abdominal wall are in the main the same for the different operations, it will be convenient first to describe them, and then to give the subsequent steps of each operation under its own title.

**The Lumbar Incision.**—This may be longitudinal, along the outer border of the sacro-lumbalis, or transverse, between the twelfth rib and the ilium, or a combination of the two. If the former is used, the patient should be placed in a position that is inclined 30° or 40° from the prone toward the opposite lateral position, and the trunk should be laterally flexed so as to enlarge the space between the twelfth rib and the crest of the ilium on the side of the operation. If the transverse incision is used, the inclination toward the opposite lateral position may advantageously be greater.

**The Longitudinal Incision** is made along the outer border of the sacro-lumbalis mass, which can be readily recognized by the finger, about two and a half to three inches from the median line, and should extend through the skin from the level of the eleventh rib to that of the crest of the ilium. It is deepened, layer by layer, until the strong middle layer of the lumbar fascia, or aponeurosis of the transversalis, is reached, after division of which the posterior surface of the quadratus lumborum is exposed. The outer border of this muscle is cleared and drawn toward the spine, and then the fat enveloping the kidney can usually be seen through the thin anterior layer of the lumbar fascia, moving up and down with the acts of respiration. Space can be advantageously gained by dividing the outer portion of the quadratus close to its attachment to the ilium. On division of the thin intervening fascia the fatty capsule of the kidney is reached, and by tearing through it and stripping it toward the sides the posterior surface of the middle and lower portions of the kidney and its pelvis is exposed to sight and touch.

Except in persons who are very fat this incision gives ample room for exploration and nephrotomy, and even for nephrectomy when the kidney is not very much enlarged. It has the advantages of not weakening the abdominal wall and thereby predisposing to hernia, and of not carrying much risk of accidentally opening the peritoneal cavity. On the other hand, the irregular relations of the pleura, and the absence or incomplete development of the twelfth rib in a certain proportion of cases, expose to accidental wounding of the pleura—a complication that has occurred and has proved fatal. Holl found the twelfth rib absent in three of sixty cadavers examined (five per cent)—a proportion so unexpectedly large, that it is now deemed an important precaution to count the ribs before beginning the operation.

A portion of the twelfth rib, and even of the eleventh, has been resected in a few cases in order to gain more room upward—a procedure which of course involves additional risk of wounding the pleura. Some room can be more safely gained by drawing the rib forcibly upward with a blunt hook.

**The Transverse Incision** is begun just within the outer margin of the sacro-lumbalis, a little below the twelfth rib, and carried outward parallel to the rib for about four inches. The muscular and aponeurotic layers are successively divided, after recognition, until the retroperitoneal layer is reached and the kidney exposed by division of its fatty capsule, as in the preceding description. Additional space can be gained by a short longitudinal cut at the inner end of the main incision.

The special advantages of this incision appear in nephrectomy, when the kidney is much enlarged. When an exceptional indication for resort to it arises from the great size of the kidney, or from its close inflammatory attachment to the peritonæum, this incision permits an easy and free opening into the peritoneal cavity, through which the hand can be introduced for exploration or to draw the kidney outward, and to facilitate the securing of the pedicle, and other later steps of the operation.

The *combination incision* consists of the longitudinal with a transverse at either or even at each end, or of a long curved incision, the convexity directed downward and backward, beginning at the posterior part of the twelfth rib and running for some distance around the flank.

Some surgeons recommend for nephrectomy a more external longitudinal incision, one running from the outer end of the eleventh rib to the crest of the ilium, because through it the anterior surface of the kidney can be more readily reached and followed inward to the hilum, and the vessels there secured.

The *anterior incision* does not differ from that of an ordinary laparotomy, except that it is usually made along the linea semilunaris instead of in the median line.

## NEPHROTOMY.

The kidney having been exposed by the lumbar incision, it remains only to cut into it to evacuate the abscess or cyst that has made the operation necessary. This may be done with the knife or the thermo-cautery. Then, if the cavity is very irregular, or if there are separate pouches, the septa should be freely divided whenever it is necessary to secure efficient drainage, and the interior of the cavity thoroughly scraped with a sharp spoon if its condition requires it. Occasionally it will be possible and desirable to draw the edges of the sac into the parietal wound and stitch them to the skin. Drainage is provided for by large rubber tubes packed around with iodoform gauze.

## NEPHROLITHOTOMY.

The posterior surface of the kidney having been freed as far as possible from its fatty capsule, the surgeon proceeds to seek for signs of the presence and location of a calculus. He may be able to recognize it by touch, grasping the kidney between the thumb and finger; or its position under the thinned cortex may be indicated by a rounded bulging of the surface and a deepening of the color; or the stone may be touched with the point of a needle introduced through the parenchyma or the wall of the pelvis. This latter mode of exploration has been proved to be free from serious risk, and when employed should be made systematically, so as to explore all accessible portions of the kidney, the needle being introduced at intervals of about half an inch.

The incision for the removal of a stone has usually been made through the posterior wall of the pelvis, and it has been made with the knife rather than with the cautery; but some recent experience has shown that an incision through the substance of the organ into the pelvis has some advantages, and does not expose to troublesome hæmorrhage. Such pressure as can be readily made by sutures checks the bleeding, and it is believed that a urinary fistula is then less likely to be established than after incision of the pelvis. If the stone lies under a changed and projecting portion of the cortex, it should be reached by an incision through the cortex radiating from the pelvis to the convex border.

If the stone is small, and free in the pelvis, or in a dilated calix, or in a pouch formed about it in the cortex, its removal is easy—it may be picked out with the fingers or forceps; but if it is large, irregular, or adherent, its removal may be very difficult—it may be necessary to break it into pieces, to divide intervening septa, or to open into separate, adjoining pouches. For the division of septa, strong scissors are said to be better than the knife or the cautery. To break a large, irregular stone, a lithotrite or strong sequestrum forceps may be used. To remove stone from cavities with irregular approaches, scoops of the most varied and bizarre shapes have been designed, few of which have received the approval of others than the inventors, and all of which might still leave the surgeon unprovided with the particular shape that was desirable for the case in hand. In a number of reported cases the surgeon has expressed the opinion, or the autopsy has shown, that stones have been left undiscovered or unremoved.

Occasionally the stone has proved to be so large, or the stones have been so numerous and so difficult of removal, that it has seemed wiser to remove the entire organ—to do a nephrectomy instead of a nephrolithotomy.

The orifice of the ureter should next be sought and that canal explored, to determine whether it is free, or whether plugged by a stone or a mass of fibrin. If such an obstruction is found, it may perhaps be pressed downward into the bladder, or washed out, as was very ingeniously done by Dr. Lange, by a stream of water directed into the distended ureter through the wound.

The stone or stones having been removed, the incision in the pelvis or in the substance of the kidney may be closed with catgut sutures, to hasten its repair and diminish the chance of the establishment of a urinary fistula. Provision for the drainage of the parietal wound, and the prompt removal of urine or pus that may escape into it, is made by rubber drains and iodoform packing; the external wound is partly closed by sutures, and a large absorbent dressing is applied.

## NEPHRECTOMY.

After three impromptu removals of the kidney by laparotomy through an error in the diagnosis, in 1861 (Wolcott), 1867 (Spiegelberg), and 1868 (Peaslee), all of which terminated fatally, Gustav Simon, of Heidelberg, first did the operation deliberately and successfully by the lumbar incision on August 2, 1869. His patient was a woman, and the condition for which the operation was undertaken was a urinary fistula following ovariotomy. During the twenty-three years that have since elapsed a large number of operations have been done for suppurative disease—tumors, cysts, calculus, urinary fistula, and abnormal mobility. The removal has always been total, except in some suppurative cases where the ligature could not be got entirely around, or where the anterior portion has been left as a disorganized shred adherent to the peritonæum. Quite recently a formal partial excision was done by Tuffier (Arch. Gén. de Méd., July, 1891); he excised a cyst, and closed the gap in the parenchyma by suture. Recent experience with exploratory incisions through the parenchyma indicates that excision of considerable portions of the organ can safely be undertaken.

The kidney may be removed through either of the two incisions above described. When the lumbar incision is used, the operation is known as *lumbar* or *extraperitoneal* nephrectomy; when the other is used, as *abdominal* or *transperitoneal* nephrectomy. The mortality of the former has thus far been much smaller than that of the latter, but there are conditions in which the latter alone is practicable, and both operations must be retained.

**Lumbar Nephrectomy.**—In making a choice between the different incisions used for approaching the kidney in the loin, it will be remembered that the larger the kidney the more advisable will it be to use a transverse incision, either alone, or combined with a short, longitudinal one at its posterior end; it can be more advantageously extended in case of need, and the peritoneal cavity can be more readily entered through it, if that be more desirable.

The details of the enucleation of the kidney vary in accordance with the varying conditions in which it may be found. If inflammation has not caused fusion of the fatty capsule and the cortex into a single lardaceous layer, or united the kidney closely to the peritonæum or colon, it is comparatively easy, after having reached the posterior surface of the kidney, to work the fingers around its convex border and its two extremities and separate it from all its attachments except the sort of pedicle constituted by the renal vessels and the ureter. This pedicle may be ligated in sections, the ligatures being passed by means of a large, full-curved aneurism or pedicle needle, or occasionally the artery can be isolated by sight or touch and tied separately, which is much to be preferred when possible, or the entire pedicle can be tied *en masse.* If the latter course is followed, an elastic ligature should be used. In some cases, instead of a ligature, a long, strong clamp has been placed on the pedicle. In making the enucleation the operator must proceed with great gentleness, especially at the extremities, where abnormal vessels may be encountered, and he must not draw the kidney too forcibly into the wound, lest he tear the vessels.

If the kidney is much altered and adherent, the need of care in detaching it is still greater. The accidents that have happened are varied and serious—laceration of the peritonæum, colon, and even, in several cases, of the vena cava, with immediately fatal result. Where the adhesion of the anterior surface of the kidney to adjoining tissues has been very close, it has been successfully practiced to remove the posterior half of the organ and then to scrape away from the remaining cut surface as much as it seemed safe to remove. The healing of the wound may require a somewhat longer time, but that is not an excessive price to pay for the greater security.

If the ureter has been separately divided, it is well to close it with a ligature, and, in case of need, to disinfect the stump.

The pouch left by the removal of the kidney should be drained and packed with iodoform gauze, and a large absorbent dressing applied over all.

**Abdominal (Transperitoneal) Nephrectomy.** — As has been said, the place of election for the parietal incision is along the linear semilunaris, the outer border of the rectus. The abdomen having been opened, and the intestines pressed aside with flat sponges, or brought out of the cavity and wrapped in hot cloths, the surgeon proceeds to strip the peritonæum from the kidney and secure the vessels. It is very desirable that the second incision in the peritonæum should be made beyond, on the outer side of the colon, so as not to interfere with its blood-supply, and this should always be done unless the size of the tumor and the position of the colon make it impracticable. The incision should be longitudinal, and sufficiently long to make the enucleation as easy as possible. It is advisable to proceed at once along the antero-internal face of the kidney to the hilum to secure the vessels, and it may even be advantageous to go directly to the artery through a special incision in the peritonæum, and secure it as the first step in the enucleation. The vein and the ureter should each be tied separately and divided between two ligatures. The size, relations, and friability of the mass introduce elements that can not be adequately treated in a general description, and it has more than once happened that very skillful and experienced surgeons have felt compelled to abandon the operation.

Enucleation is effected, as in the lumbar method, mainly by the fingers, and with preliminary ligature of threatened vessels whenever practicable. Every effort must be made to avoid infection of the cavity by the contents of the kidney or ureter.

In case the kidney is fully pedunculated and invested by the peritonæum, "floating kidney," its removal will be conducted as in the case of any other pedunculated abdominal tumor, without stripping off the peritonæum.

The sides of the gap in the posterior parietal peritonæum may be rapidly drawn together with a continuous suture, and lumbar drainage of the retroperitoneal space provided by a small incision in the loin carrying a rubber drain. The primary incision in the anterior abdominal wall is sutured in the usual manner.

## NEPHRORRHAPHY OR NEPHROPEXY.

The operation by which an abnormally movable kidney was fastened by sutures to the abdominal wall at the point where it should lie, was devised and first practiced by Hahn (Berlin) in 1881. He named it *nephrorrhaphy*, making use of a term which, with the meaning of suture or union, had already secured a place in medical terminology, as, for example, staphylorrhaphy. Trélat suggested as a more appropriate term for a similar operation upon another organ—fixation of the uterus to the abdominal wall—hysteropexy, from the Greek πήγνυμι, signifying *to attach*. The suggestion has been very generally accepted, and has been so far extended that it seems probable that *nephropexy* will wholly take the place of nephrorrhaphy.

Hahn placed his sutures in the fatty capsule, but, as experience soon showed that the fixation thus obtained was not permanent, surgeons ventured to pass them through the fibrous capsule, and finally through the substance of the kidney itself; in addition, some have excised a portion of the twelfth rib in order to place the sutures at a higher level.

The kidney is exposed, by the longitudinal lumbar incision above described, at the outer border of the sacrolumbalis, and the fatty capsule divided longitudinally and stripped back from the surface of the kidney. Three or four stout silk sutures are then passed with a curved needle from the anterior to the posterior surface, just within the convex border, at intervals of about half an inch, and then through the lumbar fascia in the line of the wound, so that when tied they hold the kidney snugly up against the abdominal wall. The wound may then be closed for primary union, or packed with iodoform gauze to heal by granulation.

Guyon sought to strengthen the cicatricial connection by removing a long strip of the fibrous capsule; and Sulzer (Deutsche Zeit. für Chir., vol. xxxi) recommends that the capsule be split and reflected, so as to form a flap which can be stitched in the parietal wound. The latter's statistics contain 80 cases, in 37 of which the sutures were passed through the substance of the kidney, and in 23 through the fibrous capsule.

# TUBERCULOSIS URO-GENITALIS.

By JOHN P. BRYSON, M. D.

**Definition.**—The series of pathological studies which began with the work of Baillie in 1794, and reached definite conclusions at the hands of Robert Koch in 1881, have put us of the present day in a position to define tuberculosis as *an infectious disease, caused by the tubercle bacillus, and characterized by the production of tissue and of inflammatory products, which appear both in the form of nodules and as a more diffuse infiltration, and which rapidly undergo caseation* (Reference Handbook of Medical Sciences, vol. vii, page 292). The initial etiological factor—the *bacillus Kochii*—may have been in the body at birth, or it may have gained entrance afterward in a great variety of ways; it may, after having done but slight damage in the way of tissue-change, lie dormant for years or even a lifetime, or, under certain favorable circumstances, be aroused to an activity which results in wide-spread disaster to tissues, organs, and life.

This disease may attack any part of the uro-genital organs. Kraske has observed a tubercular ulcer on the dorsum of the glans penis of a patient aged forty-nine, which was well demonstrated microscopically after amputation. Other equally well proved cases have been recorded. The disease may invade the uro-genital organs by way of the kidney—one or both—the bladder, the testes, the prostate, etc. As a rule, to which I think there are very few exceptions, when one of the uro-genital organs is found, clinically, to be affected, a careful search will reveal evidences of the existence of the disease in other parts of the same system. With the possible exception of a (so far as the whole body is concerned) primary tubercular infection of the external genitalia, the great mass of evidence goes to show that, at the very best, when one part is involved, the disease spreads so rapidly that for all practical purposes one may say several were simultaneously involved. There must go with this, however, the statement that the primarily involved tissues may only give clinical evidence of disease long after the moment of infection; and that this is true we have abundant pathological evidence. The chief point to observe is, that if not simultaneous the order of involvement is quite rapid. When the genito-urinary organs are attacked secondarily there is no question of the very rapid, if not simultaneous, involvement of more than one part of the tract.

In this, clinical observation coincides in all essential particulars not only with the pathology of the disease, but with both anatomy and physiology. One will hardly speak positively about primary infection—atria —when he remembers that the bacilli may enter through the lungs, leaving no trace of their passage; attack the bronchial glands first, in which case the disease is extremely insidious; develop foci there, from which they may be carried by the blood-stream to find lodgment in the epididymis or testes, there to develop, in turn, a nodule which, on account of its situation, offers palpable evidences of its existence long before the disease can be recognized in the lung by the most expert diagnostician (Bollinger, Munchener Med. Wochenschr., 1890, No. 43).

Or, to take another example, the primary lesion may be in one or more of the solitary glands of the ileum; thence the disease may extend to the overlying peritonæum. From a focus here the bacilli may drop into the recto-vesical pouch, there to set going mischief which may quickly reach the prostate by way of the post-prostatic lymphatics. Here palpation would quickly reveal the existence of a disease which had previously escaped a search even of the most careful kind. Every surgeon of experience knows how insidious and difficult of diagnosis is tuberculosis which takes this course; for if exploratory laparotomy has, as claimed by some, done little in the way of life-saving, it has taught surgeons, in the most striking manner, the evolution of tubercular peritonitis.

**Varieties.**—All the pathological varieties of tuberculosis are to be seen in the genito-urinary organs. They are:

1. Acute, general miliary tuberculosis. Of this form nothing more need be said here than that it is but a part, and a small part, of that general bodily infection which is about to terminate the life of the individual; and that it is the condition toward which all tubercular disease tends, though fortunately it is not always reached, even when the primary infection-focus may be an ulcer on the dorsum of the glans penis.

2. A distinctly circumscribed miliary tuberculosis. Here a certain area of tissue is involved in the miliary tubercular infection, the amount so affected being variable in extent and irregular in outline. At first this area is not clearly defined in outline, but gradually, as caseation goes on, the healthy tissue about the periphery offers barriers which so delay the advancement as to make this more easy, and in this way a more or less discrete tubercular nodule may be developed. This form is most frequently met with in the glands, testes, kidneys, and prostate, and generally has an infected lymphatic gland for its center.

3. A diffuse inflammation, with caseation of the inflammatory products, generally involving a considerable amount of tissue, sometimes the

whole of an organ, as, *ex. gr.*, the testis. This is by far the most frequent form of tuberculosis met with in the genito-urinary organs, especially in the testes and kidneys.

The second and third forms of the disease, as seen clinically, tend to develop nodules which are, as a rule, quite easily differentiated from the surrounding healthy tissues in those parts accessible to palpation. These nodules vary in size from that of a mustard-seed to that of a chestnut; they are wooden in density, generally painless on moderate pressure, and the larger ones are irregular in outline. If the whole of an organ, as the testis, has been involved in the caseation, the irregular and nodulated appearance and feel are quite distinct. In this respect it differs from syphilitic inflammatory change, which produces an enlargement that is smooth, even, and tends to retain the shape of the organ. I have never observed a syphilitic testis which offered that wooden or stony hardness to the touch which seems to me to characterize the tubercular nodule.

The disease is typically chronic, always begins as a localized affection, and in its progress toward general infection shows a predilection for the lymphatic channels and glands. Most important to a correct appreciation of its course is a recognition of the fact that its rate of progress is, in a marked degree, irregular. One may frequently see a certain, easily observed portion of an organ which has been attacked where the tubercular nodules have remained, to all appearances, dormant for months or years, until from some cause or combination of causes a greater rate of advancement is taken on. This may proceed a certain distance, and again either cease or become so slow as to be imperceptible. At what moment some of the poison may be released from this focus to set up a similar action in a neighboring or far-distant part is not known. Already this may have happened, and in some deeper-seated organ a focus may be in existence, and, in the same quiescent state, lying in wait to infect the whole body; or, on the other hand, this deeper-seated mischief may have been the primary one, unrecognized on account of its situation. Thus the difficulty of correctly appreciating the effects of surgical interference may be clearly seen from the standpoint of the general pathology. This difficulty lies in the uncertainty of declaring any recognized tubercular lesion to be the primary one. There is not only the best authority, but the best reason in pathology and in practice, for saying that this, in the present state of our knowledge, is clinically impossible.

**Avenues of Infection.**—Too much attention can not be paid to the question of the channels or gateways through which the pathogenic micro-organisms may reach the genito-urinary organs. Upon a determination of this, not only the question of the disease being primary or secondary body-infection will depend, but also, and in consequence, the question of treatment. In fact, these two questions—viz., primary or secondary infection—infection-atrium and channels of invasion, hold paramount sway throughout the domain of surgical tuberculosis. It is therefore necessary to review at some length the experimental, pathological, and clinical evidence bearing on the point.

It is clear that the pathogenic microbes can only reach the genito-urinary organs in one of the following ways:

1. By primary infection occurring as a local, tubercular lesion on the external genitalia or by way of the urethra.
2. By the lymphatics.
3. By extension from a neighboring organ (auto-infection).
4. By way of the blood-stream.
5. By inheritance.

It is impossible to deny that a man with a tight foreskin might, in coitus, get a few bacilli rubbed into the inner fold of the prepuce, whence they could be taken up by the lymphatic vessels and carried to a deeper gland, which would be infected, without leaving any trace of its point of entry; but it is difficult to see how this could take place without leaving some trace of its course in the way of a tuberculous lymphangitis. Still, one so often sees a lymphangitis occurring in the course of an inflammatory balanitis during a clap that this mode of invasion seems quite possible in the face of our knowledge of the influence of ordinary inflammation on tuberculosis. And, again, pathologists have taught us that the point of entry of the virus is not always visible in the shape of an ulcer (Bollinger, *loc. cit.*). In such a case the deeper-seated, primary, tubercular lesion might appear in the lymphatics about the prostate. This would be a case of hetero-infection by way of the lymphatics, and it seems all the more probable when we call to mind the fact that only a few bacilli might so enter, and the resulting deeper lesion would but slowly advance, accordingly as the rate of tubercular inflammation is so markedly influenced by the number of bacilli which are introduced. It can only be said that this mode of infection seems possible; I have been unable to find a complete and satisfactory demonstration of such a case, so commonly is the lymphatic system overlooked in autopsies. Experimental tuberculosis gives color, also, to this supposition. Baumgarten speaks of the rate of infection of the lymphatics which are in connection with the primary lesion as being "astonishing" (Baumgarten's Lehrbuch der patholog. Mykologie, vol. ii). Is it possible that a few bacilli might enter, from the same point, a vein, and be carried back to set up, in the periprostatic plexus, a tubercular inflammation? Such a thing seems far-fetched, indeed, but less so than some of the methods suggested in explanation of primary genito-urinary infection. It is certain that in practice nothing is more common than to find isolated and distinct cheesy nodules in the meshes of the vesico-prostatic venous plexus. Such a course of invasion would, again, be a primary hetero-infection by way of the blood-vascular system. Whether or not these methods of infection exist can not be determined clinically, but must be left to the experimental pathologists. Certainly, if either of these modes of entry is possible, the frequency of chronic and acute balanitis due to neglect, filth, trauma, tight foreskins, urethritis, etc., open wide the doors for entry of the virus.

It seems *a priori* far more probable that if primary genito-urinary tuberculosis arises in any of these ways, we would find more frequently than we do tubercular ulcers behind the foreskin, on the glans penis, in and about the fossa navicularis urethræ, and on the cutaneous covering of the external genitalia. It has been suggested that the tubercular nature of these ulcers has been overlooked, so commonly are all ulcers about the external genitalia of both sexes regarded as due to some other virus, and this seems quite probable. Since tubercular ulcers, which are external, and liable to mixed infection on that account, often heal, it is not impossible that in this way some of those cases of chancres that are not followed by general syphilitic infection may be explained. Such so-called chancres may not be followed by syphilis, but may, in the course of a greater length of time, be followed by genito-urinary tuberculosis; and in this way another of those now quite commonly mentioned resemblances between the two diseases be recognized.

That primary infection can or does ever take place by way of the healthy urethra—that is, infection of the prostate, kidney, testes, and their adnexa—seems to me in the highest degree improbable, unless by some mechanical aid, such as the introduction of unclean instruments, injections, etc. Even in those frequently occurring cases of acute and chronic suppurative inflammation, which might offer a foothold, it seems much more likely that the gateway of the lymphatics and blood-vessels would be opened. The anatomy and physiology of the urethra, the obstacle offered by the compressor urethræ muscle, the fact that the tubercle bacilli do not multiply in the urine, and have no power of motion of themselves, all speak against the view, seemingly held by some, that the bacilli travel backward along a urethra to develop a primary tuberculosis of the prostate, vesiculæ, epididymis, or even the renal pelvis. There is no doubt whatever of the fact that careless catheterization, injection, and surgical manipulation generally will bring about this result; but that hetero-infection, per urethram, may occur from coitus is justly held to be far-fetched. Increasing knowledge of the pathogeny and more accurate observation are likely to show that those cases of apparently primary tuberculosis of the prostato-vesical region occurring in old men, who, being prostatics, use catheters which are not clean, are really such. When we see tuberculosis of the uro-genital organs of an old man, we are naturally surprised, since we are aware of the fact that the disease belongs to adolescence and early manhood, and we are entitled to suppose some unusual cause. The only two cases of apparently primary uro-genital tuberculosis which I have seen were in prostatics who had used the catheter, and who were both unclean in their habits. In one, an apparently primary tubercular prostatitis developed rather suddenly. The more acute inflammation subsided, leaving tubercular nodules in the gland. In three months tubercular epididymo-orchitis had progressed so far that I castrated him. Five months later the opposite testis was almost completely disorganized, when it too was removed by curetting. The wounds healed well. Six years afterward the peritonæum and liver became involved, and eighteen months after this (in June, 1891) the patient died of acute general miliary tuberculosis. The kidneys remained free of disease up to the last fourteen days of his life, when albumin and casts appeared in the urine. In the second case the disease also began in the prostate, and there was already a mild, chronic, simple pyelonephritis, from extension. The onset was acute, and an abscess formed in the prostate, discharging through the urethra. There was an extensive destruction of the prostate and membranous urethra, and the tubercular ulceration extended to the meatus urethræ externus, and upon the glans penis. Its tubercular character was well demonstrated. The renal disease did not seem to be aggravated, and the testes remained healthy up to his death, which occurred from exhaustion nearly two years after the onset of the tuberculosis. It will be noted in this case that the cause of death was not generally miliary tuberculosis, but chronic uræmia from the simple pyelonephritis.

These cases bear all the clinical appearances of primary genito-urinary tuberculosis, but that they can not positively be so identified the following, which but for the autopsy would have gone on my case-book as one of primary urethral tuberculosis, will show: A man aged thirty-four applied to my clinical assistant complaining of an intense pain and burning on urination. He could distinctly locate the painful spot about an inch and a half behind the meatus externus. There was no discharge and no thickening of the urethral wall to be felt from the outside. His previous history was not obtained. An attempt to pass a filiform instrument failed, because of its point catching at the painful spot and exciting the greatest distress. No further attempt at instrumentation was made, but an alkaline diluent was given and the patient advised to go into hospital. The next morning he was found dead, sitting over a vessel into which he had passed some few ounces of urine. At the autopsy, made under the coroner's directions, there was found a tubercular ulcer the size of a five-cent piece on the floor of the urethra at the point where the patient located the painful sensation. The prostate, vesiculæ, kidneys, and the other uro-genitalia were sound, at least not diseased, so far as gross inspection could detect. The urethral ulcer was demonstrated microscopically to be tubercular; it was not deep or indurated at the base, and did not appear to be of long standing. There was no stricture in front of it or behind it; the meatus was not narrow, nor the foreskin tight. Though in no way accounting for the death of the patient, it would nevertheless have been looked upon as a primary infection had not distinct and old tubercular foci been found in the lungs (bronchial glands) and in the post-cervical lymphatics. Unfortunately, the brain-case was not opened. While the urethral ulcer in this case might be regarded as a hetero-inoculation, it certainly was not the primary tubercular lesion for the body. A more careful research would doubtless have shown beginning tuberculosis of other organs, as well as the cause of death.

In all the recorded cases where primary tuberculosis of the prostate has been alleged to have followed an acute inflammation (notably a gonorrhœa), and where the inflammatory process, extending backward, has been supposed to have carried with it the infecting agent, the evidence of such a mode of invasion has appeared to me entirely inadequate to support the assertion so commonly made. Certainly this is true of the cases which have been observed by me. So often do we see cases of tuberculosis, the first demonstrable evidence of which is about the prostato-vesical region, in young men or boys who have never had clap, who have never had an instrument passed or an injection, and who present no evidences of any previous disease of the uro-genitalia whatever, that it seems far more in consonance with our present knowledge to say that the acute inflammation, acting after the manner of a traumatism, has roused into activity a slumbering or latent tuberculosis, which was present long before the acute attack, perhaps dated even from birth. That this latter actually occurs I have had occasion to observe in several cases. That a tubercular lesion, clearly demonstrable, may remain quiescent for many years—from birth to the accession of puberty in some cases, past puberty in others, and still in others even into old age—is, I suppose, within the observation of all surgeons of experience.

The genito-urinary apparatus having once been invaded, in whatever part, the question of the spread of the disease to the other parts becomes of the greatest importance. Only one part of this question will be considered here—viz., the passage along the surface of the healthy mucous membranes of the infecting agent, from one point to another, as from the bladder by way of the ureters to the renal pelvis, or from the prostatic urethra to the epididymis along the vas deferens. The other or affirmative parts of the evidence bearing on this point will come more properly under the heading of Spread by the Blood-Vascular Channels.

Throughout the entire literature of surgical tuberculosis two observations are quite commonly made: first, that the testes, the kidneys, and the prostate are most commonly first affected; and, second, that the prostate is rarely—some say never—missed. Long ago Dron urged the value of frequent digital examination of the prostate by way of the rectum in doubtful cases, evidently recognizing the great frequency of the affection of this organ. In order to explain the infection of one organ after another by way of the genital and urinary passages, the most ingenious and far-fetched arguments have been brought forward, and we are asked in each one to accept as proved, statements which have in them elements of the highest improbability; and as our knowledge of the pathology of the disease advances these become all the more glaring. That the kidney being first invaded, the bacilli may be carried by the urine downward to infect the bladder, prostatic urethra, and thence the gland itself, seems in every way easy of belief, but a critical search of the literature does not show, so far as I know, a single recorded case where this has been proved to be the course of the disease. All that have come under my observation fail to show that the disease did not reach the lower passages in some other of the well-known ways. The frequent occurrence of the disease in the periprostatic tissues instead of on the surface of the prostatic mucous membrane, when the course of the infection has been supposed to be along the urinary channels, has not been given sufficient importance in this connection. Nevertheless, that such a course is occasionally taken we are not permitted to doubt; it is in regard to the frequency of such a course of infection that objection is here made. Reports of such cases invariably fail to eliminate one chief source of error—viz., the existence of tubercular disease in other parts of the body and the point of primary body infection.

What has just been said applies equally and in all respects to those cases where the disease is alleged to have leaped from the testis to the prostate by way of the vas deferens, without visibly extending along this duct.

Back of all this lies the question of whether we can ever have a primary body infection occurring in the testis or kidney. On this point pathologists are at variance. For my own part, I fully accept the statement of Baumgarten (*loc. cit.*, vol. ii, page 625), that there are cases of congenital tuberculosis.

Much more difficult of belief is the statement, so frequently made, that the disease may spring from the bladder to the kidney by way of the ureter without invading that duct in its course from below upward. Only the existence of very exceptional conditions could bring about any such result. The bacilli, having no power of independent motion, must in such a case mount the duct against an almost constantly flowing physiological current, having gained access to the ureter by way of one of the most perfectly contrived valves in the body. We know nothing of a to-and-fro movement of urine in the ureter, and are equally ignorant of an antiperistalsis, such as we see in the bowel, which might carry the inert bacilli up to the pelvis. The whole duct, being collapsible, acts as a valve in any part of its course. Nor does the fact that other forms of inflammation reach the pelvis and kidney from the bladder by extension avail as an explanation. The tubercle bacilli do not multiply in the urine, as do all those other micro-organisms which, as is well known, bring about this result. On the whole, one must reject this method of extension on the grounds of improbability, and all the more readily since there are no well-ascertained clinical facts which require its aid in explanation. Almost as much can be said of that other alleged method of extension, viz., from the prostate or vesiculæ to the testis by way of the vas deferens. Here, however, there may be an antiperistalsis to overcome some of the mechanical difficulties; but, on the other hand, the tubercle bacilli have not yet been demonstrated in the semen. The ciliary movement would seem to stand opposed rather than in favor of such a course. Again, one may say that there are no clinical facts which, in the presence of our knowledge of other well-ascertained methods of extension, require the dragging in of a hypothesis which involves so many difficulties. More accurate clinical observation, more care in autopsies, and advancing knowledge of pathology will soon—if they have not already—render such explanations unnecessary.

That the disease may and does advance both up the ureter from the bladder and down the vas deferens from the prostate, continuously or by dissemination, according to its well-known course on the surface of mucous membranes, there is, of course, no intention here to question.

Of the methods of invasion of the uro-genital organs by way of the lymphatics, there is no need to speak further here, so well has this field been worked over by the pathologists. The predilection of the pathogenic organisms to the lymphatic tissues, and the manner of the dissemination of the disease along these avenues, does, however, require more attention from the clinical student and more care in autopsies than it has heretofore received (Councilman, *loc. cit.*). I will only mention the fact that extension of the disease by way of the lymphatics offers an adequate explanation of the fact, often to be seen in practice, of the appearance of disseminated tubercles under, instead of in the form of an ulcer upon, the mucous membrane.

The manner of the invasion of the uro-genital tract by extension from neighboring and surrounding organs and tissues is now, thanks to the work of pathologists, well understood, though it is not so extensively recognized or searched for clinically by surgeons as it might be with advantage. The kidneys, the ureters, the bladder, the prostate, the seminal vesicles, the vasa deferentia may all be invaded by extension of the disease from surrounding structures. Often, indeed, the appearance of tubercular inflammation in one of the uro-genital organs offers to the surgeon the first satisfactory indication of the nature of a disease which has long been known to affect some neighboring part.

It is by way of the peritonæum that the disease most frequently reaches the uro-genital tract by extension from neighboring organs, though the kidney is sometimes invaded from a tubercular bone lesion of the spinal column. The use of the cystoscope has greatly enlarged our means of diagnosis in these cases, and has enabled me to recognize in two instances the advancement of the disease from the peritonæum and its gradual spread, by dissemination, under the vesical mucous membrane, in one case on the anterior and in the other on the posterior vesical wall toward the fundus. In both cases the bladder wall toward the cervix was for a long time free of disease. In another case of kyphosis from tubercular disease of the spine a tubercular abscess of the kidney developed. But in all three of these cases disease in and about the prostato-vesical region was demonstrable long before the other lesions were made out clearly. And this, in men, has been my constant observation : that so far as the uro-genital organs are concerned, disease apparently taking this course always appears—or is demonstrable—first about the prostato-vesical region.

In women the anatomical separation of the genital and urinary organs offers a much better opportunity to observe a distinct primary invasion of the bladder from the peritonæum. Several such cases I have been able to observe and to diagnosticate by means of the cystoscope long before the bacilli could be identified in the urine, though in due time this was done in each instance.

My own observation leads to the opinion that extension to the uro-genital tract from the peritonæum is of much more frequent occurrence than is generally believed by surgeons. The fact that the peritoneal fluid is a medium in which the bacilli may multiply ; the dependent position of the recto-vesical fold ; the ease with which the bacilli can pass through this thin membrane ; its close relationship to the vesiculæ, the vasa deferentia, and the vesico-prostatic, venous and lymphatic plexuses, and the well-known relationship between genito-urinary and peritoneal inflammations—all afford explanation of the clinical observation. The insidious character of tubercular peritonitis, slowly and for a long time advancing, as it often does, without even a fever-rise to give warning of its presence, and with little or no pain, taken in connection with the fact that surgeons do not so frequently as they might take into consideration that there is a peritoneal fold (vesico-rectal) within reach of the finger-tip, leads also to the belief that this course of tubercular progress is not so generally recognized as its importance justifies.

Contrary to what appears to be generally believed, the hæmatic channels offer a common avenue for the invasion by the disease of the genito-urinary system; and, besides offering a better explanation of the clinical phenomena, this mode of infection, better than any other, accounts for some of those cases of supposed primary infection of the deeper-seated organs, such as the testis, the kidneys, etc.

The strong predisposition of certain parts of the genito-urinary apparatus, viz., the testes, the prostate, and their adnexa, to tubercular disease has been noticed by clinical observers for the longest time. Naturally the testis, offering as it does the most favorable opportunities for observation, took first rank in the beginning for frequency of attack. It was not long, however, until the prostato-vesical region attracted attention, and at the present day competent observers are entirely agreed that this is, by many times, the most frequently affected of all the genito-urinary system. My own observation in a large number of cases is in accord with the opinion expressed by many, that this portion is never skipped in genito-urinary tuberculosis. And not only in clinical observation but in pathological research have we the confirmation of this fact. Jani, whose observations were published (after his death) by C. Weigert (Virchow's Archiv, Bd. ciii, 1886), and confirmed by the latter, carefully studying the genitalia of nine consumptives whose sexual organs presented no evidences of tubercular disease whatever, found tubercle bacilli five out of eight times in the testis and four out of six times in the prostate. The bacilli lay, in the testis, partly within and partly close beside the cellular and granular (crumbling) contents of the seminal tubules; in the prostate, always in the neighborhood of the glandular epithelium. "Great numbers of bacilli" were also observed by him in the prostatic juice (secretion?) in another case (of miliary tuberculosis). In still another case of chronic pulmonary phthisis with severe intestinal tuberculosis, he found several tubercle bacilli in the folds of the mucous membrane of the seminal tubules. He judges that they reached this locality from the peritonæum by means of the ciliary movement. In none of these cases was there the least evidence of pathological alteration of the tissues of the testis. Nasse (Virchow's Archiv, Bd. cv, 1886) found in the kidney local disseminated tuberculosis, whose origin, he thinks, must be sought in the rupture of a tubercle into an artery. Durand-Fardel (Archiv de Physiol., Norm. et Path., 1886, page 393), who claims to have been the first to demonstrate the transportation, in men, of the tubercle bacilli by the blood-current, in examining a tuberculous human kidney found collections of the bacilli, sometimes in very great quantities, in the vessels as well as in the glomeruli, partly such as were involved in the tuberculous process, but partly also those in whose neighborhood the tissue was still perfectly free from the histological appearances of the tubercular process. In the vessels, the bacilli lay imbedded in thrombotic material. In the glomeruli, they occupied partly the walls, partly the lumen of the capillary loops. This position of the bacilli in the lumen of the capillary loops, or in the walls of the glomeruli, which showed no histological evidences of being diseased, is of the greatest importance, since they could only reach that situation by the blood-vascular channels. According to Weigert, there may be a direct embolism of bacillus-containing thrombi from the pulmonary veins, and Haller says such a condition may come from the aortic valves. Haller, Weichselbaum, and others had already demonstrated microscopically the presence of the tubercle bacillus in the post-mortem contents (blood) of the heart and great vessels, and in the flowing blood of men. C. Bollinger (*loc. cit.*) says that, "as regards primary tuberculosis of the testicles, joints, and bones, we must consider that a latent hæmatogenic infection is understood, which leaves as little trace of its point of entry as does a primary septic endocarditis or an osteomyelitis." Birch-Hirsehfeld and Baumgarten both accept a hæmatogenic infection of the kidney and testis.

I am fully aware of the fact that good observers (Korzyureki, Salzman, and others) can be quoted against the infection of the uro-genital organs by way of the hæmatic channels, but a careful examination of the evidence upon which the assertion is based reveals a failure in each case to demonstrate the condition of other organs in such a way as to clearly exclude an auto-infection. In fact, it is only by ignoring the now well-demonstrated power of the blood to carry from point to point, from organ to organ, in the body the infecting agent, that one could feel justified in drawing the conclusions deduced by some. The disposition to generalize on a few imperfectly observed cases is quite as apparent in genito-urinary tuberculosis as in any other. For my own part, I can but say that the conclusion to which the clinical observation of a large number of cases had been steadily driving me was hastened and confirmed by the results obtained by the experimental, pathological, and clinical observations of the authors quoted and referred to above. To me it seems that we are now in position to say with much confidence that in the great majority of cases the pathogenic factor reaches the parts of the genito-urinary organs which are involved in the tubercular process by way of the hæmatic and lymphatic channels or by extension from neighboring organs or tissues; that the order of frequency of invasion would place the hæmatic channels first; and that a true primary (for the body) genito-urinary tuberculosis is one of the rarest of occurrences.

**Heredity.**—Hereditary infection has not heretofore been considered in this article, but it must be of frequent occurrence. I have myself seen six cases of tubercular nodules in the testes of young children, which clearly dated from birth. I have also seen two cases of tuberculous testis in old men, whose histories indicated that the disease dated from early childhood. In one, there never had been any vesical symptoms, though the periprostatic tissues were involved. He consulted me on account of an annoying balanitis which arose during a transcontinental railway journey, but has never had any uneasiness except frequency of urination to attract his attention to the sexual organs. In the other, there has existed for many years a chronic cystitis of the neck without hæmaturia. In both these cases there is not only testicular but prostatic tuberculosis, and both declare that the hard nodules in the testes have been noticed by them since boyhood. They are brothers, and not only have a family history of tuberculosis, but some of the children of each have succumbed to this disease.

More careful and systematic study of these cases will undoubtedly increase the list of cases of hereditary genito-urinary tuberculosis, and will serve at the same time to clear up some of the mooted points in regard to primary tuberculosis of the testes. This seems all the more certain when we call to mind the fact that it is in hereditary surgical tuberculosis that we see the most marked tendency to remain latent; so that we can readily see how it is that a latent or quiescent tuberculosis of the testes or epididymis may escape observation until the evolution of puberty determines an increased activity of the disease as well as of the affected organ in a way to bring it under observation. I have already urged the necessity of exercising much reserve in pronouncing as to primary genito-urinary tuberculosis, and I would now advise equal caution in declaring as to the duration of any tubercular lesion that may be discovered in the genito-urinary cycle, and more especially when that lesion is situated in the testis or, as it most frequently is, in the periprostatic region. More extended clinical observation of these cases has led me to give much greater weight to the opinion expressed by Baumgarten. He says (*loc. cit.*): "We can not regard the infection by the digestive tract as the principal source of human tuberculosis, although it is of more importance than the infection by means of the respiratory tract or the skin and outer mucous membrane; and infection by sexual intercourse, which must *a priori* be considered, must be judged to be of no moment, on account of the extremely rare occurrence of a spontaneous, undoubtedly primary tuberculosis of the outer genitalia—or of the genitalia at all—therefore only one mode of infection remains possible, that by inheritance."

We are now in position to discuss the more positive evidence bearing on the question of the early—perhaps simultaneous—involvement of more than one part of the genito-urinary system, when once it is invaded, and the nearly related subject of the greatest tendency to early involvement shown by the prostato-vesical and periprostatic region. The necessity hardly exists of urging the vital importance to diagnosis and the influence on (surgical) treatment which is here apparent.

As is well known, there is great difference of opinion among pathologists as to the portion of the uro-genital organs first affected in tuberculosis. Virchow, Ziegler, Forster, Steinthal, and others hold to the opinion that it always begins in the kidney; while Rokitansky, Birch-Hirschfeld, Bardenheuer, etc., take the opposite view, thinking the initial point is not only in the testis, but in the epididymis. H. Eilers (Baumgarten's Jahrsbericht, vol. v, 1889), who thinks the disease begins in the tail and not, as is generally supposed, in the head of the epididymis, joins with the last-named authors. He (Eilers) thinks that testicular tuberculosis very seldom exists alone, other parts being usually found diseased at the same time, and he also speaks of primary testicular tuberculosis as being only "probable." Korzyurcki (Centralblatt für Bakteriologie, vol. iv, 1888), who believes in an infection *per urethram*, declares that the prostate seems never to be skipped. Steinthal, along with all others who hold to the opinion that the kidney is most frequently the site of the initial lesion, thinks that the prostate is very early involved in the tuberculous process. In fact, all authors of note, no matter how widely they may differ on other points in the pathology, as on the question of primary lesions and the initial points in the genito-urinary organs, are agreed in asserting the great frequency of prostatic involvement and the rarity with which we fail to note the missing of this region in advanced tubercular disease of the uro-genitalia.

If, now, we take into consideration the facts that some tissues reveal a far greater predisposition to tubercular disease than others, as for instance the lungs, which show this even by metastasis (Bollinger); that vigor of onset and the rate of progress of the diseased foci are most markedly influenced by the number of bacilli introduced, and the local power of resistance; that the bacilli have been demonstrated in the blood as well as in the healthy testis and prostate (Jani), and in the healthy portions of the kidney (Durand-Fardel), which they could reach only by way of the hæmatic channels; that the rate of progress in the affected areas is essentially irregular, with a tendency to remain latent or quiescent for an indefinite time; that tubercular inflammation is not suppurative inflammation, and that suppuration takes place only after a mixed infection with pyogenic bacteria (Garri, Baumgarten, etc.); that infection by way of the blood-vascular system does not always mean miliary tuberculosis, but that a lymphatic gland may even be infected from the blood; that the bacilli do not multiply in the urine, and that they have not yet been demonstrated in the semen; that a tubercular nodule may exist for an indefinite time in the periprostatic tissues without exciting any subjective symptoms more than it does when situated in the caput epididymis or the rete testis, and hence might easily escape detection; that in extension from the peritonæum tubercular disease is most apt to reach the periprostatic tissues first, on account of the favorable circumstances of the dependent position of the recto-vesical fold; and, finally, that other inflammation, both acute and chronic, slight traumata, and even the evolution occurring at puberty, as well as increased functional activity (sexual excesses), are well known to be capable of exciting a sudden increased activity of the tubercular process—we ought to be in position to see how it is that the disease most frequently reaches the genito-urinary organs by way of the hæmatic channels, or the lymphatics by extension; how it is that the prostate and its surroundings and adnexa are most frequently first of the genito-urinary organs to show evidence of the disease; and how it is that they seem never to be missed, as well as to comprehend nearly all the other clinical phenomena of tuberculosis uro-genitalis.

**General Diagnosis.**—The foregoing is intended chiefly to apply to the questions of diagnosis and treatment; indeed, it serves its best purpose in the narrower field of pathological as distinguished from the anatomical diagnosis. The latter, with the means at present at hand, is not difficult in the great majority of cases, and is arrived at by the same means and methods employed in locating any chronic inflammatory process occurring within the genito-urinary cycle. When, as quite commonly occurs, a few disseminated tubercular nodules exist in the rete testis, the epididymis, and in the periprostatic tissues, the subjective symptoms may be almost or quite *nil*, so that such a disease may remain undetected for the longest time. Generally, however, there exists some frequency of urination, for which one has to account, and such patients are generally told that they have "nervous" bladders, an opinion which can be easily confirmed by the failure to find anything out of the way in the urinalysis, except, perhaps, slight polyuria, with rather low specific gravity. If instrumentation is resorted to, or irrigation, all the vesical symptoms are aggravated, and slight hæmorrhage may be excited. More likely, the deep urethral irritation exciting thereto, the patient indulges in fornication, and this may set the process going more rapidly, and bring it into notice; or, what is still more likely, he contracts a clap which, running backward, quickly arouses the slumbering tuberculosis, with disastrous results to the prostato-vesical region. It is in such cases that, after the acute symptoms have subsided, the error is apt to be committed of supposing that the clap has brought about a prostatic tuberculosis, with extension to the testes by way of the vasa deferentia, and especially is this likely to occur if the surgeon has never seen the patient previously, or has failed to make a thorough examination. In children we may not have, in such a case, even so much as a frequency of urination to attract attention—a fact that may be accounted for on the grounds that, owing to the rudimentary or undeveloped state of the prostate, tuberculosis of that organ does not occur. Neither is enuresis in children ever, so far as I have been able to observe, caused by tuberculosis—a fact which, to my mind, seems easy of explanation. If tuberculosis affects the child's bladder-neck at all, it is the mucous membrane, or the submucosa, which is involved, and this causes not only frequency of urination but a dysuria, which rouses the attention, and there is an absence of that irritability of the vesical neck, so characteristic of enuresis. It is in children that we see those cases where the tubercular disease seems to be most clearly confined to the testis. Nevertheless, no case that has been examined by me has ever failed to reveal evidences of the involvement of the vesical neck, either by frequency of urination, without polyuria and dysuria, or a tendency to bleed on the gentlest introduction of an instrument. Another evidence of the frequency of the involvement of the bladder in these cases is the frequency with which they are examined for stone—symptoms of which they present—and the history given that such examinations have been negative, with the result only of aggravating the symptoms and causing bleeding. In these cases, where even the fewest and smallest shot-like nodules can be felt in the testes, suspicion of tubercular disease about the vesical neck ought to be excited, and, besides frequent and careful palpation per rectum, repeated examination of the urine for the bacilli should be made. For it is in these (the most difficult for the purpose) cases that the early (perhaps simultaneous) involvement of the vesico-prostatic region and the testis affords means of differentiating between syphilis and tuberculosis. Syphilis is known not to attack the prostate and bladder, while congenital syphilitic orchitis may so closely resemble tuberculosis that it may easily be mistaken for it. In any doubtful case, therefore, a careful investigation of the vesico-prostatic region is imperative—all the more so when we call to mind the fact that the two diseases may exist at the same time (mixed infection). This holds good equally in adult and acquired as well as in infantile and congenital syphilis and tuberculosis. In the case of adults, however, the differential diagnosis is not difficult.

The early (to say the least) involvement of the prostatic region in all tubercular cases affords valuable assistance in differentiating between cancer or sarcoma testis and tuberculosis—a distinction which it is sometimes impossible to arrive at on any other grounds; for, as is well known, both cancer and sarcoma advance toward a general or bodily infection by another route than the prostato-vesical region.

In children we sometimes see tuberculosis of the vesical neck without any discoverable testicular involvement. I have observed one such case, where the tubercular cystitis was complicated by secondary (phosphatic) calculi, in a child aged four. When the patient, who had been very much neglected, came under my observation a tubercular peritonitis was present, and the history seemed to show that the vesical disease was by extension from the peritonæum. The patient succumbed to tubercular meningitis. Neither in the testes, epididymis, nor cords could I detect the least evidence of tuberculosis.

By many times the most difficult problem to solve is when a differential, pathological diagnosis is to be made between primary cancer and so-called primary tuberculosis of the prostate; for, if there is a resemblance between testicular syphilis and tuberculosis, there is a closer one between cancer and tuberculosis of the prostate. I do not find this point discussed in the literature of the subject, and am therefore compelled in my treatment of it to rely chiefly on my own observations, which, in the case of cancer of the prostate, are by no means extensive. Leaving for the present outside of this consideration the detection and identification of the pathogenic bacilli, a comparison of the symptomatology of the two diseases leads to the conclusion that our chief reliance must be on the relative differences in the pain and hæmorrhage; for we must not overlook the fact that neither of these diseases of itself is pyogenic, but that both of them may have the suppurative process ingrafted upon their clinical courses. From the beginning to the end cancer bleeds, as we might expect it to do, seeing the extreme vascularity of the malignant growth, and also that the growth begins from the surface in a way to favorably dispose to hæmorrhage. This disposition to hæmorrhage also increases as the disease progresses. Contrary to what is generally supposed, the disposition to hæmorrhage is not great in tubercular disease. There may be periods in its course when we have sharp bleedings, but these are short, and usually belong to the earlier stages and to those cases where the disease is making progress in or immediately under the mucous membrane; hence, so far from growing worse, the hæmorrhage diminishes as the ulceration proceeds toward the deeper tissues. I have seen cases where the entire prostate had been destroyed, the rectum opened, and a perineal fistula found with only a few insignificant bleedings. Even in these cases of disseminated tuberculosis about the cervix one may irrigate, fill the bladder sufficiently, introduce the cystoscope, and have a look without exciting sufficient bleeding to obscure the field of vision, a thing one could never do in cancer. To say the very least, the bleeding in tuberculosis is intermittent, while in cancer it is continuous. The pain also is quite different. The lightning-like, lancinating pains of cancer, requiring the vigorous exhibition of opiates for their relief, are, in my experience, never seen in tuberculosis of the prostate. In the latter, burning and scalding on urination are present in the beginning, but grow less also as the disease advances to complete destruction of the mucosa, where most of the nerves are distributed; but in cancer there is, if any difference, a decided increase. Again, cancer of the prostate is well known to be one of the most painful of diseases, while tuberculosis, far more frequent, has not that repute. It may be said, then, that, while in their earlier stages a differential diagnosis between cancer and tuberculosis of the prostate may for a time be impossible, a continued and careful study will enable the surgeon to distinguish them, even in those cases where there is failure to identify the bacilli, with sufficient certainty to avoid an exploratory operation, which on the one hand would be useless, and on the other distinctly detrimental.

Those pathological changes wrought by tuberculosis, and which are to be distinguished by palpation in those organs accessible to this mode of examination, are of the highest importance for diagnosis. As the surgeon sees it, tuberculosis appears in the shape of quite hard, usually painless nodules, ranging in size from small shot or mustard-seed to that of a horse-chestnut. Where a larger size is attained, as often happens in a testicle, it will on careful examination be found to be made up of several of the larger-sized nodules, either coalesced or held firmly together by fibrous bands or meshes. This gives the whole mass the feel and even the appearance of being lobulated, or else so nodulated as to be quite irregular in outline, though the general appearance and shape of the organ may be to a certain extent retained. One never sees such large nodules in the prostate as in the testis; long before they are developed to this size ulceration has taken place, and a more or less rapid destruction by coagulative necrosis is taking place on the free surface of the ulcer. More frequently one makes out a few (two or three) nodules the size of a pea in the head or body of the epididymis or in the substance of the gland. There is generally a difference in their sizes if more than one are present.

In the testis one frequently encounters fine, shot-like disseminated tubercles, scattered on the capsule and about the rete testis. These might exist, of this size, within the gland, without being detected by palpation. They rarely occur in the cord or on the prostatic capsule. The vas deferens, when affected at all, gives the impression to the touch as if it were a string of beads, or, in other cases, as if bits of tubing were strung together, the indurated parts being longer than they are thick. Most frequently two or more of these conditions exist in the same testicle. In no case which has come under my observation has either syphilis, cancer, or sarcoma of the testicle presented the same evidences as are described above. Neither has acute or chronic non-tubercular inflammation.

Where tuberculosis testis begins and where the disease may be first discovered clinically, may be very different things; H. Eilers (*loc. cit.*) is responsible for the statement recently made, that the tail and not the head of the epididymis is the most frequent starting-point. I know of no clinical confirmation of this statement; and only introduced it here in order to more clearly bring into contrast the differences in diagnostic value of the small, hard mass in the cauda often left after an acute epididymitis following gonorrhœa—which may persist for a lifetime without being followed by any evidence whatever of tuberculosis—and those disseminated nodules, which one always finds either in the body or head of the epididymis, in the testis proper or scattered over its capsule, in tubercular disease of this gland. These small knots following epididymitis from extension are frequently the cause, when bilateral, of an obstructive sterility, while it is well known that bilateral tubercular epididymitis is very rarely the cause of azoöspermism, even when the organs are extensively involved. These nodules at the tail of the epididymis are not to be confounded with the tubercular ones occurring elsewhere in the testis.

If the kidneys were amenable to palpation, we should doubtless have the same evidences of tubercular disease presented by them as in the case of the testes. Warrant for this is found in those cases brought to autopsy, where the nodular condition is to be made out very clearly in the softly elastic organ, before section. The small, shot-like nodules scattered over the capsule are also to be felt here, and in one case seen by me, where an exploratory lumbotomy permitted thorough palpation, both the larger nodules within the substance and the disseminated tubercles on the capsule offered satisfactory evidence of the nature of the disease before section into the gland was made.

Nowhere throughout the whole genito-urinary system does palpation offer the same advantages to diagnosis as those parts having the prostate for a centre and the range of the finger in the rectum for a circumference; for it is in this region—the one rarely if ever missed by tuberculosis uro-genitalis, no matter where the starting-point may be—that the *tactus eruditus* can be brought to the investigation of the greatest number of organs in a way to detect those larger and smaller nodules, which are so characteristic of the disease. Moreover, there is here, within reach of the finger, the point of junction of the urinary and genital tracts as well as the point where, to a large extent, the vascular and lymphatic systems come together; so that one might say there are anatomical and physiological grounds, as well as pathological observation, for an explanation of the great frequency of tubercular attack. The well-known influence of blood-stains in localizing and favoring the development of the pathogenic bacteria has free play here in the oft-repeated vascular changes occurring in the different stages of sexual activity. In no inflammation, either acute or chronic, in which the tubercle bacilli play no part, do we find those small, hard, almost painless nodules in the prostatic substance, in the walls of the seminal vesicles, on the prostatic capsule, at the prostato-vesicular junction, in the intervesicular angle, in the portion of the bladder-wall bounded by the prostate and the vesiculæ, or in the meshes of the surrounding vesico-prostatic plexus. There may be only one or two of such nodules, or, as in the case of the testis, there may be many of them matted together, but their detection here is of the highest diagnostic importance; so much so, indeed, that in doubtful cases of genito-urinary disease careful and repeated palpation should always be made; and in cases where they are detected, a guarded prognosis is demanded.

For a final decision, based on the discovery of the tubercle bacilli in the urine, a long time may be required.

In prostatic tuberculosis one may often be able to detect small, hard masses, about the size of a pea, which are clearly developed in the vesico-prostatic plexus of veins, for they are movable over the capsule of the gland and are not attached to the rectal wall. They are of much diagnostic value also, a fact to which I have called attention some years ago (St. Louis Courier of Medicine). A. T. Cabot, of Boston, who has also studied them, thinks they may be infected lymphatic glands, but my belief was that they were perivascular tubercular nodules similar to those found in the lungs. In one case, which I had studied clinically, and which was brought to autopsy, the specimen was so carelessly handled and became so spoiled that the microscopist to whom it was submitted declared his inability to make a positive statement. The cheesy mass which was squeezed out on section seemed to come from a periprostatic vein.

The nonsuppurative character of tuberculous inflammation is also of diagnostic value in the early stages of the disease, and would be of much more service in this regard if suppurative inflammation were not so frequently ingrafted upon its course by mixed infection through careless and septic instrumentation. When we remember that one of the most common ways of assisting in a diagnosis, as well as treatment, is the introduction of an instrument of some kind, often by the patient himself; that even if the surgeon is scrupulously careful of his instruments, he is not equally so of the anterior urethra through which they must pass to reach the bladder; that a pot of dirty vaseline often supplies the lubricant; and that suppurative anterior urethritis treated by injections is of very common occurrence—there is left little room for surprise that one so rarely sees a purely tubercular formation about the vesical neck and on the surface of the mucous membrane.

That which renders the diagnosis absolute and certain is the identification of the pathogenic tubercle bacilli in the urine; and in all cases—and more especially doubtful ones—careful and persistent efforts should be made with this end in view. But that such efforts fail of success in clearly tubercular cases, for a long time at least, is well known to surgeons having experience of these cases—so well known, in fact, that throughout the literature of the subject it is a common observation that absence of the bacilli from the urine is no evidence of the nonexistence of tuberculosis. This absence of the pathogenic micro-organisms, at first sight so striking as to cause surprise, receives, however, adequate explanation at the hands of pathological anatomy. As is well known, the bacilli have never been demonstrated in the seminal fluid. Jani (Baumgarten's Jahresbericht, 1886), quoted above, failed to find them in the contents of the seminal vesicles of nine consumptives, though they were present in the testicles, prostate, and "prostatic juice," these glands being free of evidences of tubercular disease. I caused the seminal fluid of four young men having tubercular disease of the testis and prostate (one had a nodule apparently in the seminal vesicle, and two had nodulated vasa deferentia) to be repeatedly searched for the bacilli by competent microscopists, who failed to find them in any case. In one of these cases the bacilli were tolerably abundant in the urinary sediment and in all, the spermatic filaments showed that the testes were active. In one case I removed the testicle, and in one the organ had been removed by another surgeon before the patient came under my care, the presence of the active spermatozoa showing that the fluid examined came from a tubercular gland. Where the testes, the prostate seminal vesicles, and periprostatic tissues are alone the seats of the disease, we could not expect to find bacilli by an examination either of the urine or semen. Neither may we expect to find them in the urine in those cases where the tract is invaded from the peritonæum, so long as the infected portions remain beneath an intact mucous membrane. In a case, still under my observation, in which the cystoscope revealed a submucous tubercular patch on the anterior of the fundus, over four months elapsed, and there occurred three attacks of hæmaturia—clearly of vesical origin—before bacilli appeared in the urine. There were nodules in and around the prostate, and symptoms of tubercular peritonitis, when he came under observation.*

It is in those cases of extensive tubercular ulceration of the urinary passages, which are freely washed by the urine and which are not suppurating, that one may expect to more quickly and frequently find the bacilli in the sediment. One can only say, however, that this is probably true, for these cases are not ordinarily watched clinically in such a way as to determine the point. No systematic attempt to estimate the number of bacilli present in the urine is known to me, but my own observations lead to the belief that the number is never large. Where they have been found at all, from one to four, or at most five, on one cover-glass, is quite the average. One never sees here the same numbers as in the sputum from a tuberculous lung, even in those cases where destruction seems to be going on at a rapid rate. In practice, even the flocculent discharge from a sinus connected with a tubercular testicle has, in my hands, often yielded negative results with the microscope when the pulpy mass subsequently removed with a curette contained them in large numbers.

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* In this case there was clearly an interference by the disease with the detrusor vesicæ, several tests showing residual urine to the amount of four to six ounces, without any prostatic or other obstruction to account for it. The urine was rather abundant, of low specific gravity (1008–1012), and contained no pus. The diagnosis, made on the clinical history and the physical examination, was subsequently confirmed by the discovery of tubercle bacilli in the urine. Great care was taken to avoid infection with pus microbes, and the nonsuppurative character of the inflammation with the ability to exclude malignancy were relied upon as strong evidence in the pathological diagnosis. The case is one of a group constituting the basis of a clinical lecture to be found in the International Clinics, Philadelphia, Lippincott.

Here, again, a reference to the pathological anatomy of tubercle seems to offer an adequate explanation. Koch, Baumgarten, and others have demonstrated the fact that the bacilli lie, not on or near the surface of an ulcer, but underneath that portion which is undergoing the coagulation necrosis; hence they are not easily washed up from below by the discharges, or off the surface by the flowing urine. In the caseous center of an imbedded tubercle, the bacilli are very scant, sometimes entirely absent, while the mural arrangement is quite marked. Moreover, unless there is suppuration from mixed infection, the discharge from such a tubercular ulcer is quite small. To trust, then, to the caseous detritus thrown off from the surface of such an ulcer into the urinary stream is, as actually happens in practice, to be often disappointed. When suppuration takes place, we usually have urinary decomposition, with the addition to the urine of such a large number of other micro-organisms as greatly to add to the difficulty of identifying the specific bacilli, and the differentiation by culture-experiments is hardly applicable in clinical work.

In spite of all these difficulties, a persistent search of the urinary sediments will rarely fail to determine the question of their tuberculous character, when the inflammation is situated upon or very near the mucous surface of the urinary passages.* In no instance, where the clinical symptoms, the history and physical examination offer a slight hint, especially in those chronic cases of inflammation along the urinary passages which do not yield to other treatment, should this persistent and systematic search for the tubercle bacilli be neglected.

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* In practice, the finding of the tubercle bacilli, especially in those cases where there is no suppuration, and where the urine is clean and contains only the normal sediment, is greatly facilitated by the addition of some egg-albumen, so as to obtain such a viscid deposit as will enable the microscopist to get a good "spread." It seems hardly necessary here to say that the operator should be sure that the albumen which is expected to entrap and carry to the bottom of the urine-glass the bacilli should itself be free of those organisms.

In my own observation, embracing six cases (five of which were demonstrated by post-mortem and one by lumbotomy), the bacilli were found in large numbers when the kidney is involved in the tubercular process. Not only were there numerous bacilli in these cases, but they were readily demonstrated. I should therefore be inclined to suspect a renal lesion in any case where considerable numbers were readily demonstrable in the urine. The question of the kidney being attacked is, however, one of anatomical diagnosis, to be determined by the presence or absence of casts in the urinary sediments, and needs but slight mention here. In the case of primary (for the urinary organs) renal tuberculosis the pathological diagnosis is not ordinarily difficult unless there is an accompanying suppurative pyelitis, for the confusion caused by a suppurating cystitis can be readily eliminated by the well-known method of vesical irrigation previous to the withdrawal of the urine for examination.

When the bladder is the first of the uro-genital organs to be attacked, the fact that the disease spreads by dissemination, and not by diffusion, serves as a diagnostic help, now that its walls have been brought into view by means of the cystoscope. The pale, salmon color of the normal vesical wall, and the transparency of the epithelium, enabling one to see the vessels coursing underneath, offer exceptional advantage for the detection of those pathological changes which advance from below. Changes in color and in the vessels are especially easy of detection.

Finally, it can be said that, since one has so frequently in practice to make a diagnosis without that positive evidence furnished by the identification of the tubercle bacilli in the urine, and since we can not expect the seminal fluid to furnish it, it is still possible to arrive at sufficiently accurate conclusions for all practical purposes by a comparison which will bring prominently into view the differences between the grosser manifestations of tubercular and other forms of inflammation. For this purpose there is not a well-demonstrated point in the pathology, the pathogenesis, the rate of progress, or the mode of its invasion which is not both available and important. A diagnosis thus made, by squaring the clinical history and the results of physical exploration with the now well-ascertained facts of an advanced pathology, will be found in the end to depend in large measure upon what are even yet too often spoken of as "fine points." And such a method, requiring a more extended knowledge of the pathology and evolution of the disease, is of greater avail in enlightening our prognosis and directing our treatment than the mere fixing of a label after the discovery or the essential etiological factor could possibly be.

In view of the fact that improved methods and means of diagnosis have lately come into vogue, and of the manifest advantage to be derived from an early recognition of the pathological nature of a complaint which so closely mimics other and different states, as well as for purposes of reference and proper classification, it seems advisable to give some brief account of the symptoms and treatment of tuberculosis of the different organs composing the genito-urinary cycle. And here again it is necessary to eliminate from our consideration the general or miliary form of tuberculosis, for the reason that its rapid progress, and its all but simultaneous invasion of extensive areas, puts it beyond the reach of surgical help. In what follows, especial attention is given to the symptoms that announce the earliest periods of invasion, and the term "primary" has reference only to the invasion of the genito-urinary system.

### PRIMARY RENAL TUBERCULOSIS.

Here, as is well known, groups of miliary tubercles irrupt from beneath the mucous membrane of the pelvis, or in the glomerular zone of the cortex. In the present state of our clinical knowledge it is not possible to distinguish the symptoms evoked by difference in the localities primarily involved. Nor is it greatly important to do so, since one locality is quickly invaded after the other, and the different sets of symptoms blend. Fenwick expresses the belief that, in the pelvic form of the disease, blood and pus appear in the urine in small amounts either coincidently with renal pain or very soon after its appearance; that renal colic appears relatively earlier than in the cortical form; that the stages are passed through more rapidly; and that the bladder is affected earlier. Where, however, the cortex is primarily invaded, polyuria would first appear; owing to the irritation of the excreting tissues, hæmorrhage would be slower to begin; and, later than in the pelvic form, the frequency of urination, caused by vesical irritation, would take the place of the increase of quantity. The hæmorrhage from the different localities would also vary. In the pelvic form it should be slight and intermittent, but in the case of a sloughing out of a portion of the cortex, bleeding should be profuse but more transient.

**Symptoms.**—In any case the symptoms taken in their entirety closely resemble those of renal calculus, and in this resemblance the mimetic character of tuberculosis of these organs is well illustrated. For the purpose of distinguishing between the early stages of these two diseases, Fenwick has constructed the following table :

| PRIMARY RENAL TUBERCLE IN EARLY STAGE. | RENAL STONE IN EARLY STAGE. |
|---|---|
| Family history of phthisis or cancer. | Family history negative, or of gout or gravel. |
| Age between twenty and forty. | Age about forty. |
| Personal history: Perhaps tuberculous bones, joint or gland disease; very rarely any previous urinary symptoms. | Personal history: Negative, except perhaps the passage of gravel; of a "weak" loin; of testicular neuralgia or "sciatica." |
| Symptoms, onset: Polyuria of a murky type (the frequency of micturition being due to the quantity passed, not to irritation), vague lumbar pain, or a sudden chill, and severe pain in one kidney, but rarely colic. Some frequency of micturition in the early stages at night, from irritation of acrid urine. | Symptoms, onset: Vague lumbar aching or a sudden colic. Frequency of micturition, due to irritation; small quantities passed often, and in day—not at night—relieved by rest. |
| Colics appear later, are usually less severe, are more easily under the control of drugs, do not usually retract the testicle, and are preceded by rose-red blood, if they are induced by ulceration and not blockage. | Colics: More or less severe, according to composition and size of stone, followed by blood. |
| Hæmaturia: Slight in amount, more or less persistent, uninfluenced by rest. | Hæmaturia: Intimately mixed; much more marked than in tubercle; dependent on exercise. |
| Urine: Cloudy at the outset from admixture of mucus and pus. Acid, low specific gravity. Light-colored, depositing a thin layer of pus with streaks of blood, *débris* of connective tissue. Small clumps of caseous material. Albumin appears early. | Urine: Clear at outset, containing evidences of calculus in the shape of crystals. Acid, normal specific gravity. Pus later in course of case, and then only forming a deposit when pyelitis has been induced. |
| Tubercle bacillus found, but with difficulty and after much search, in acid urine. | |
| Inoculation of urine deposit into animals (Rovsing, Jacobson). | |
| General condition: Patient ailing, "never feels well," is anæmic, easily tired; no loss of appetite. | General condition: Patient may enjoy first-rate health between colics. |

No matter where the process begins in the upper urinary passages, the bladder will quickly show signs of irritation. Both the bacilli and the products of their growth and activity are swept downward with the urinary stream and are held long in contact with the vesical mucous membrane. Here at the anterior portions of the trigone and about the ureteric orifices, the ptomaines, probably, by their irritating action, prepare the way for a true bacillary surface-infection. Be this as it may, we very soon have a highly irritable vesical neck.

**Diagnosis.**—The cystoscope comes efficiently into play for diagnostic purposes. But it should be employed with the greatest care, and with all the precautions to be presently mentioned in connection with the use of instruments in vesical tuberculosis.

The presence of tubercle bacilli in the urinary sediments should be persistently sought for. They will usually be found.

It is apparent that many of the points for diagnosis can only be developed by judicious cross-questioning, and that much will depend on the intelligence with which the patient has observed the symptoms. For these reasons it is advisable to go over the history several times, allowing a proper interval between the examinations for refreshing the memory. Owing to mixed infection, pus appears in the urine rather early in these cases, generally before the vesical irritation has tempted to a resort to local treatment. Septic catheterization is especially to be avoided, for a cystitis at once clouds the clinical picture and leaves one to grope in the dark during many days of valuable time.

As to whether one or both kidneys are diseased may be determined partly by the localization of the pain and distress in one or the other loin, but our main reliance must be in the catheterization of the ureters, with the aid of the new and improved cystoscope.

**Treatment.**—It is of primary importance to avoid as far as possible all instrumentation, all washings, and all injections of caustic or antiseptic solutions into the middle and lower urinary passages. Even in the earliest stages of renal tuberculosis frequency of urination and vesical irritability are quite common. This tempts the surgeon to fly to local treatment, especially if, as is not infrequently the case, the patient is a young man and has been the subject of a chronic urethritis, or thinks he has. The judicious surgeon who has his patient's interests at heart will resort to the use of instruments in the urethra and bladder neck with the greatest reluctance in these cases. This caution can not be urged with too great insistence. The surgeon should keep constantly in mind the fact that frequent urination caused by the polyuria does not, and that the frequency caused by vesical irritability, even when accompanied by slight bleeding at the end of the act, may not, mean vesical infection. The former is easily accounted for and does not attract so much attention, but the latter is often erroneously taken to indicate the necessity of local treatment. In the earlier stages this frequency of irritability only means congestion and swelling about the interior portion of the bladder, due to contact with urine loaded with ptomaines or other products of renal tuberculosis. This is the moment in the evolution of the disease when the greatest advantage is to be gained by the use of general or constitutional anti-tubercular treatment. Renal and vesical distress are best quieted by codein. This drug acts more like belladonna in its quieting effects on the excitable detrusor, and has at the same time the analgesic properties of morphine. Moreover, there is less danger of the dreadful opium-habit from its use. Cod-liver oil, the hypophosphites, malt, fatty foods, creasote, or, better still, sandal oil, with change to a warm and dry climate, are now of the greatest service, and, I am persuaded by observation, will more frequently result in cure or at least obsolescence of the disease than is generally believed.

**Surgical Interference.**—This is not only of advantage in certain cases, but is imperatively demanded in others. If the disease remains fairly localized in one kidney, and does not improve under the treatment just named, an exploratory lumbotomy may be done with the view of clearing up the diagnosis, removing any stone that may be causing or adding to the trouble, freeing any sloughing portions of the renal substance, or draining the renal pelvis and diverting the stream of tuberculous urine, in order to avoid infection of the ureters and lower urinary passages. Where the onset is sudden and vigorous, or where an old and "latent" tuberculosis of one kidney is suddenly lighted up into an acute trouble, splitting the renal capsule may be the means of saving a large portion of the kidney which is about to be destroyed by undue pressure. It seems quite possible to remove, as in the case of the testis, only the diseased portions of the gland, leaving the healthy parts to functionate. My own rather limited observations in these cases lead me to think that whenever the tuberculous kidney is incised, it is better to open the pelvis and drain for a long while through a lumbar fistula. In one case under my care, where there was frequent renal colic from the blockage of the left ureter with sloughs, and in spite of the fact that the bladder was extensively infected, the right kidney being apparently healthy, I opened the loin, removed a quarter of the kidney substance which was softened, opened and drained the pelvis for a fortnight, with the result of apparently saving the remaining portion of the gland. Gradual obsolescence of the vesical tuberculosis followed, and the patient has now, in a fair state of health, resumed his business in a Southern city.

In one case, in the practice of another surgeon, violent general tuberculosis followed quickly on the incision of tubercular nodules in the right kidney, causing death within the fortnight. In this case the pelvis was not opened, and there was no drainage. The lower urinary passages were already affected, and it was probable that the patient, a woman, was on the eve of a general tuberculosis at the time of the operation.

Even when the lower urinary passages are infected and both kidneys are involved in the tuberculous disease, surgical interference may yet be of some service. Here it is of the greatest importance to save all the remaining healthy renal tissue. As is well known, the tubercular process, except in the general miliary form, is erosive in its action, often leaving healthy functionating gland tissue in the immediate neighborhood of that which is destroyed or irretrievably diseased. In those cases of nephro-phthisis where the destruction of gland tissue is proceeding in the direction of the cortex from the pelvis, there can be little doubt that drainage would be of advantage, as it is in the case of the bladder. This drainage through the loin would, by diverting the stream of tuberculous urine, enhance the opportunities to benefit the diseased bladder by local and general treatment. By improving the general health, obsolescence at least, and, in a certain number of cases, cure, may come most unexpectedly. The advantage of keeping the tuberculous areas of the lower urinary passages as free from moisture as possible is manifest.

The involvement of other organs which are essential to the maintenance of life in the tuberculous process, has the same bearing on the question of operation as in other forms of surgical tuberculosis. In any event, the strictest attention is to be paid to the state of the digestive organs, to diet, and to climatic influences.

If the use of "tuberculin," or other similar treatment, is to be instituted with the intent to cause a casting off of the tuberculous tissue, it seems indispensable that the pelvis of the kidney should be opened, in order to provide a means of exit other than the ureters.

## TUBERCULOSIS OF THE BLADDER.

*Tuberculosis of the bladder* is rarely primary in the urinary cycle, this viscus generally suffering in consequence of disease of a neighboring or associated organ. Where the disease does primarily attack the bladder, it seems beyond question that the trigonal submucosa is by far the most likely to suffer.

**Symptoms and Diagnosis.**—The irruption of the tubercles in this situation develops a series of symptoms closely resembling those of vesical calculus. The patient is generally young—fifteen to twenty-five—gives a history of masturbation, to which he attaches much etiological importance, and has a family history of tuberculosis or cancer and a personal one of enuresis up to four or five years of age. There is a story of gradually increasing frequency of urination for a few months, chiefly during the day. Later on the nights are disturbed, and about this time blood appears at the end of the act. There is pain also in the mid-penis, with a decided vesical tenesmus, and an occasional sudden stoppage of the stream with an increase of distress. As the disease progresses the nights are more and more disturbed by calls to urinate, and an increase is noted in the hypogastric pain when the bladder is disturbed. If the disease is active, there may be some sloughing out of portions of the mucosa, with bright but transient hæmorrhages.

The points to be noted for differential diagnosis from stone are: (1) the absence of history of the passage of renal calculus; (2) the fact that exercise, while showing some effect, does not make so marked an increase of vesical irritability; (3) the situation of the pain in the mid-penis, and the fact that it does not pass forward under the glans; (4) the sudden arrest of the stream by a voluntary contraction of the compressor urethræ, so as to relieve the pain caused by the passage of urine along the urethra, instead of the reverse condition of the pain being caused by the sudden blockage of the meatus internus by the stone; (5) the more rapidly increasing nocturnal frequency of urination, and its clear dependence on distention reflex; and (6) the growing evidences of a contracting bladder.

The cystoscope and bacteriological research of the urinary sediments will, in the great majority of cases, quickly resolve any doubts.

The bladder may be invaded from above in two ways: first, by surface inoculation by the stream of tuberculous urine from the kidney or its pelvis; and, second, by continuity along the line of the ureter. The former mode of extension is most frequent. The urine from a tuberculous kidney is loaded with ptomaines and other irritating products of tubercular inflammation. These first irritate the trigonal mucous surface, causing swelling and congestion, the symptoms of which are frequency of urination, due to irritation of the vesical neck and not to distention reflex. Later on there is excoriation of the surface, and some blood issues with the last drops when tenesmus appears on the scene. Day and night frequency are almost equal. There is scalding urination, the appearance of the fluid voided depending upon the extent and severity of the renal disease. The state is one of more or less intense surface irritation of that portion of the bladder most richly supplied with sensory nerves. The symptoms are almost exactly similar to those caused by an extension backward of an acute urethritis (gonorrhœa). The patient "wants to void the urine all the time," and no relief comes from emptying the bladder.

The soil being thus well prepared by a bath of ptomaines, tubercular infection of the submucosa easily takes place through an excoriated patch or a rent made by an instrument. Such patients should not, except it be unavoidable, be sounded for stone, and judicious cross-examination will generally elicit a sufficient discrepancy to place the surgeon on his guard. There are generally both pus and blood as well as tubercle bacilli in the urine. There is also turbidity from abundant detritus.

Where there is extension by continuity from the ureter, swelling, congestion, excoriation, and finally ulceration creep in by the ureteric orifice and extend along the corresponding trigonal limb. It is by the aid of the cystoscope alone that we can observe this process, which, so far as the bladder is concerned, may be almost symptomless, and must be frequently obscured by the clinical manifestations belonging to the state just described above.

True to its mimetic character, this form of the disease often closely simulates renal calculus.

All these forms of tuberculous cystitis are surface infections, and symptoms appear promptly after invasion. Where the attack comes from the other direction the disease may progress considerably before it is recognized, or, indeed, before the patient is aware that there is any bladder ailment at all. In the case of a primary invasion of the middle coat of the bladder from the blood-vascular channels, the symptoms are almost *nil*, and when they appear at all consist of (1) weakening of the detrusor muscle-plane, showing itself in a slowness to start the stream, weakness of flow, and difficulty in emptying the bladder ; (2) accumulation of some residual urine in the later stages ; (3) a gnawing pain behind the pubes when the bladder is disturbed, which is not quickly relieved by urination ; and (4) by slight hæmorrhages from the over-distention. Here there is no frequency of urination, no pus, no bacilli, and rarely any blood in the urine. When this occurs, as I have seen in a man above fifty-five, the mimicry of obstructive prostatic disease is striking.

When the infectious process takes the course of a primary tuberculous enteritis, localized peritonitis over an infected solitary gland of the ileum, and peritonitis of the anterior or posterior peritoneal folds of the bladder from the bacillary accumulation in the dependent pouches, the disease reaches the muscular coat before the mucous membrane is involved. In such a case we have the same symptom-group, with the enteric and peritoneal set added. The bowel-disease is not easily recognized, and localized tubercular peritonitis is often symptomless.

Moreover, several months may intervene before any visible symptoms appear, the first of which to attract attention may be hæmaturia, without pus or bacilli in the urine. In such a case the cystoscope offers the only means of resolving the doubts. It shows a patchy, disseminated tuberculosis under the transparent mucous lining of the bladder, sometimes on the anterior portion of the fundus, sometimes over the vault itself. I am persuaded from observation that this course is more frequently taken by the disease than is generally suspected, as it was impossible to observe it in precystoscopic practice. The post-mortem table would hardly enable pathologists to trace backward this line of attack.

The bladder is sometimes invaded from an infected seminal vesicle, and here again the mimicry of calculous disease is so close as to frequently tempt the most careful to a highly injurious, even dangerous, instrumentation. In several cases I have noted that, owing to the matting together of the tissues of the affected side, the disturbed bladder called urgently for urination, being unable to hold more than five or six ounces; the pain ceased when about half of this was voided; there was at the end of the act much straining, and the extrusion of a few drops of bloody urine at the last, and the distress slowly subsided as the bladder was partly filled again. The distress at the end of urination seemed to me to be due to the bending of the stiffened seminal vesicle and to the pressure about the inflamed meatus internus. As differing from the symptoms of calculous disease, the day and night frequency are about the same. The cystoscope shows a patchy inflammation along the line of the affected vesicle, the other part of the bladder being free of disease. Though more frequent in early life, this form of the disease may be seen in persons of advanced age.

Coming from the prostate, the infection creeps rather uniformly up from the anterior angle of the trigonum, probably climbing by the lymphatics of the submucous coat. The symptoms are those of cystitis of the neck, with frequently bright but transitory hæmorrhages. A finger in the rectum will detect an unusual sensitiveness of the intervesicular space, especially if the bladder be partly filled. Distention reflex is marked. Nodules may be sometimes felt in the bladder wall below the anterior angle. Detection of the prostatic disease ought to do away with the necessity of cystoscopy or other instrumentation.

**Cystoscopy,** an invaluable agency in diagnosis, prognosis, and in directing treatment, should be practiced with the utmost care and gentleness, and only after the most thorough precautions have been taken to avoid aggravating the disease. In no disease is the integrity of the protective epithelial lining of the urinary tract of more service.

A very slight traumatism of the trigonal mucosa may convert a mere surface irritation into an infection, when tinder becomes fire. In case the attack is coming from the other direction, a tear will admit the urine in such a way as to convert a dry and sluggish infected area into a moist and astonishingly active focus. The following mode of procedure will be found to serve the best purpose. Boil the instruments, and use only a mildly borated glycerin for a lubricant. The anterior urethra should then be washed with a one-to-two-per-cent solution of carbolic acid (the salicylic-acid solutions do not act well here, giving much pain, and softening the epithelium). This is best done by injecting the urethra from the meatus several times and allowing it to empty itself. Next an Ultzmann's syringe-point is introduced into the membranous part and a syringeful or two of an aqueous solution of five-per-cent cocaine hydrochlorate and one per cent of carbolic acid thrown into the vesical neck. Then, and not until then, should a catheter be introduced to empty the bladder and distend it for inspection. If these precautions be taken, an anæsthetic will rarely be required; and it is of advantage not to give one, for we want the patient's sensations felt and noted as diagnostic aids. In the vast majority of cases the writer has succeeded in getting satisfactory observations without other anæsthetic than cocaine used in this way. In estimating the cystoscopic picture, however, one should keep in mind the fact that a five-per-cent solution of cocaine blanches the mucosa by causing vascular contraction, and that it also causes paresis of the detrusor vesicæ, so that a bladder that would previously project a smart stream from a catheter will, after cocainization, often allow it to flow out only by siphonage. This is a matter of importance in a disease one of the chief symptoms of which is often a weakened bladder force.

The use of the cystoscope has also the advantage of enabling us to do away with the stone-searcher, one of the most dangerous instruments that may be used against a tuberculous bladder.

**Treatment.**—The treatment of vesical tuberculosis is much the same, no matter whether it be primary or secondary, and without regard to surface or deep infection. One should not lose sight of the fact that the disease often becomes obsolescent without treatment, and true phthisis of this viscus is one of the rarest occurrences.

Caustic application—silver nitrate and zinc solutions—are only mentioned to be condemned. Antiseptic and bactericidal douches do no good, but are positively harmful by spreading the infection. We can never stamp out the disease by such means. Iodoform has been weighed in the balance and found wanting. Corrosive-sublimate solutions give frightful pain, and spread the disease. Counterirritations over the pubes or in the perinæum, still used by some, add to the patient's discomfort, and are powerless to help. The mineral waters, buchu, etc., are of no service, and often disturb the digestive organs.

When the disease becomes obsolete, the bladder wall is thickened, stiffened, and contracted. It is highly irritable and friable, and holds only a few ounces. The reaction of such a bladder to distention is marked. This makes fluid distention, which is of so much service in the concentric hypertrophy of simple cystitis and stricture, inadmissible and dangerous.

In the early stages of surface irritation gentle aseptic washing of the bladder with simple warm water is safe and very soothing. Oil of sandalwood and cubebs, by the stomach, do good service in any stage. Our main reliance must be in general treatment. Climate, diet, and the antitubercular remedies often improve the patient in the most astonishing way, hastening a quite satisfactory obsolescence. Cold and damp climates are to be avoided, and a sedentary employment chosen whenever possible. An appeal to surgical means is very doubtful in all, and very disastrous in the majority of cases. Drainage is not beneficial. If the pain and sloughing demand cystotomy for relief, the sectio alta is preferable. The perineal section often becomes infected, and an obstinate fistula with burrowing backward, even into the rectum, will occur with uncomfortable frequency. The suprapubic cut often heals with a soft (infected ?) red-banded scar, which easily spreads and permits a hernia to protrude after the patient has assumed the erect posture. On the whole, surgery offers very little to these patients, and meddlesome surgery does much harm.

## TUBERCULOSIS OF THE SEMINAL VESICLES.

Tuberculosis of the seminal vesicles is treated under the heading of diseases of these organs. It is proper to call attention here to the fact that, owing to their close anatomical relations with the bladder, symptoms appear rather promptly after infection, and these symptoms have to do chiefly with urination.

## TUBERCULOSIS OF THE PROSTATE.

**Symptoms and Diagnosis.**—Where there are a few small tubercular nodules on the capsule or near the periphery of the gland, the disease may be symptomless. They are to be felt easily, however, from the rectum. Nodules situated about the vesiculo-prostatic junction are apt to obstruct the duct, and determine an engorged condition of the corresponding vesicle. Here, too, the proximity to the bladder wall develops symptoms of cystitis of the neck, and the vesicular peristalsis during coitus sets up a painful, throbbing sensation, of which the patient is apt to complain. In some of these cases bloody or "currant-jelly" semen may be emitted.

In other cases a tuberculous nodule of moderate size, and not active, may be imbedded in the substance of a prostatic lobe, and still cause but slight symptoms. Where they are discrete they can usually be felt from the rectum as indurated spots in the soft structure of the gland. There must, however, be many cases where they are indistinguishable by palpation, and where symptoms appear only after the infection has crept upward by the lymphatics to the vesical neck. Some authors allude to an enlarged and indurated condition of the gland produced by early and excessive masturbation, which may be confounded with this form of tuberculosis. It seems much more plausible, in the absence of exact pathological knowledge, to attribute the excessive masturbation as well as the enlarged and indurated state to tuberculosis. Aside from atrophy, I am not aware of any pathological state that can be clearly connected with masturbation, however excessive or early practiced, as the sole etiological factor. It seems but right, then, that in all such cases tuberculosis should be strongly suspected, though a positive diagnosis may be properly withheld to await developments. This condition occurs in early life, about the time of the evolution of puberty, and the functional activity, along with the growth and development of the organ, will soon resolve the doubt. The precaution is all the more important when we consider the dangers of instrumentation in these cases.

Some of these cases do not come under the surgeon's care until they have an acute, parenchymatous (gonorrhœal) inflammation ingrafted on the chronic ("latent") tubercular disease. At that moment the diagnosis as to tubercular disease is entirely impossible while one is face to face with the most disastrous consequences; for it is in these very cases that we see total destruction of the prostatic mass by gangrene.

In still another form the tuberculous onset is acute, the gland swelling rapidly from the irritation (ptomaines?) produced by a very few bacilli, resulting in a smooth, symmetrical, and painful enlargement. Rectal and vesical symptoms are prominent from the beginning. Acute retention may necessitate the use of the catheter, which aggravates the disease. Here the diagnosis is impossible except by the exclusion of other causes, or the implication of associated organs in the tubercular process. The presence of gonorrhœa in any stage, especially if undergoing local treatment, entirely obscures the picture. A tubercular nodule in the testis or cord may give a valuable hint, but these are frequently absent.

In this form two determinations are possible: (1) the acute swelling may subside, leaving one or more hardened nodules in the parenchyma, and the disease become obsolete; or (2) the gland may soften in places, abscesses form, break into the urethra, and a true prostatic phthisis be set up which gradually erodes the entire organ by cheesy necrosis. I have seen such destructive process hollow out the prostate as lupus might do, destroy the membranous urethra, open into the perinæum, while at the same time it burrowed into the post-prostatic tissue without ceasing until the rectum had been invaded. These patients usually go on until they succumb to general miliary tuberculosis. Obscure as it may be in the beginning, the diagnosis is not difficult after the disease has well set in on its way. The prognosis is most unfavorable.

**Treatment.**—In the acute forms active antiphlogistic measures are required. Where the patient could bear it, I have apparently seen good results from the internal administration of tartar emetic in doses of $\frac{1}{24}$th grain every three hours until the heart showed signs of being affected, as was first suggested by Milton, of London, for perineal abscess. Hot douches to the perinæum have a soothing effect. It is best to move the bowels freely in the beginning with a cathartic, and leave them alone for several days. Pain is to be quieted with opiates, preferably codein. After the acute stage has subsided, or in the chronic forms of the disease, obsolescence is to be courted by a general antitubercular treatment, which should also include such remedies as quiet sexual activity.

All instrumentation, except such as is absolutely required, is to be avoided, and the same is to be said of caustic and antiseptic applications to the prostatic urethra. Surgical means are of no service here; a prostatic abscess may need opening from the perinæum. When an incision is required, the surgeon should, if possible, avoid opening the urethra. Dry applications, which are at the same time astringent, such as tannic and boric acids, are best for local applications to these open ulcerations. The curette and the cautery serve rather to irritate the parts and thereby spread the disease.

## TUBERCULOSIS OF THE URETHRA.

*Tuberculosis of the Urethra* is doubtless very rare as a primary infection, either of the body or of the uro-genital cycle. The posterior part of the duct may be invaded from the prostate by continuity, or, less frequently, by the tuberculous products of cystic or nephritic disease. Mere surface irritation of the deep urethra by tuberculous urine is one of the common signs of disease of the urinary passages posterior to the prostate. Peripheric prostatic tuberculosis reaches the duct, even in its posterior part, very slowly, and often lets it go free entirely. Ulcerative destruction of the membranous portion is not very uncommon, and tuberculous ulcers of the anterior portion may occur. Miliary urethral tuberculosis is quite common when the disease is about to put an end to the patient's life.

**Symptoms and Diagnosis.**—The chief symptoms of urethral tuberculosis are excessive pain on urination or instrumentation, strong tendency to bleeding on slight manipulation, and the disposition to urethral fever on very slight provocation. In the few cases that have come under my observation satisfactory cocaine anæsthesia was not possible. This rendered the use of the urethroscope quite difficult and unsatisfactory, but taught me to suspect the disease in those cases where there was a disproportionate amount of pain in a urethra not acutely inflamed.

The urethral discharge is often purulent, and tubercle bacilli are found, if at all, very rarely. A deep and very painful ulcer may exist with very little or even no discharge from the meatus, but the first ounce or two of urine passed will nearly always contain tubercular detritus. In several cases seen by me the ulcers were remarkable for their clean and smooth appearance and feel.

Fenwick very properly calls attention to the fact that this disease may easily be mistaken for stricture, and adds that "we recognize the difference by the extraordinary amount of pain which is caused by the most delicate instrumentation, and this even after a strong solution of cocaine has been applied." In a case that remained doubtful, general anæsthesia for urethroscopy would be justifiable.

**Treatment.**—This should be symptomatic and supportive. Instrumentation is to be avoided. Topical application of astringents dissolved in distilled extract of hamamelis, and washes of mild thallin solutions, have been of most service in my hands. Iodoform, extolled by some, proved useless. Morphine, dissolved in the washes, seemed to have more effect is quieting pain than cocaine.

## TUBERCULOSIS OF THE TESTIS AND CORD.

The disease is encountered here in three forms: (1) where the onset is sudden and acute, the gland and epididymis swelling rapidly, becoming hot, red, and painful, this subsiding and leaving hardish nodules of varying sizes in the gland-substance or epididymis; (2) where the process is more chronic and less active, the hard nodules forming gradually, apparently from the coalescence of several small foci of infection; and (3) the gradual and often quite painless development of very small spotlike nodules upon the tunica albuginea or in the meshes of the epididymis. In the acute form the swelling may be so rapid as to cause gangrene, unless the fibrous capsule be split, and in this case the testis may "fungate."

**Symptoms and Diagnosis.**—The clinical picture is much like that of an acute gonorrhœal epididymo-orchitis, and is not to be distinguished from it in those frequent instances of the lighting up of an acute upon an old or "latent" tuberculosis by gonorrhœal extension. When this form occurs in a patient without gonorrhœa and after some slight traumatism, the inference is easily drawn. These cases can also be separated from syphilitic orchitis by the rapidity of the process and the greater amount of pain in the tubercular disease.

There is rarely any difficulty in distinguishing between obsolete or quiescent tuberculosis and syphilis of the testis. The diffuse orchitis of syphilis, swelling the gland and epididymis alike, developing a smooth, painless, and heavy oval tumor, which undergoes involution by atrophy of the organ, presents to palpation a very different object from the nodulated, irregular, often fistulous, tuberculous testis. Gummatous deposits, however, of the testis may closely simulate tubercle. The exclusion of syphilis and the existence of tubercular nodules in other organs—especially the prostate—most frequently settle the diagnosis. In fact, as already mentioned, the all but constant involvement of more than one of the uro-genital organs in the tubercular disease is our safest means for differentiating the affections. Where all other means fail, the touchstone of treatment may be applied. Gummatous lesions of the testis which remain any length of time in the same condition are rare. One should not lose sight of the fact that syphilis and tuberculosis are not infrequently concomitant diseases.

The diagnosis of tuberculosis of the epididymis is dependent on the discovery of the hardish nodules, from the size of small shot to that of a pea, in these soft structures. Here, owing to the elasticity of the organ, the nodules can be readily felt, and one may often recognize the irregular shape of even quite small masses. Even when the whole testis and epididymis are indurated by the tubercular infiltration, the nodulated and irregular feel is quite characteristic.

**Treatment.**—This should be supportive and antitubercular. The organ should be carefully protected against even the slightest traumatism, by suspension and attention to the clothing. Sexual quiet should be courted and enjoined.

Surgical measures should be held as a last resort. In the present state of aseptic surgery, castration, even when unilateral, is rarely necessary. The high importance to man's intellectual and moral state of keeping at least a small share of testicular substance in physiological connection with the circulation and with the cerebro-spinal centers; the suspicion that the opposite organ or the prostate is already implicated; the strong doubt, almost amounting to a conviction, that the disease is never primary, for the body, in the testis, as well as the now common acknowledgment on the part of the most experienced observers, that castration does not have an appreciable influence on the progress of the disease toward a general infection, should make us hesitate long before removing even one of these organs which have so striking an influence on the general nutritive processes. The chances of obsolescence, the wonderful recuperative power of the gland, and the now well-demonstrated efficacy of the removal of the tuberculous foci without serious damage to the remaining healthy portions, leaves only a very small number of cases to demand castration.

When the tubercular nodules remain latent in the testes, especially in those cases where there are evidences of coincident prostatic tuberculosis, they can safely be let alone. If they take on an activity that even threatens trouble, the organ can be incised, the tuberculous areas curetted, cauterized, washed freely, dusted with iodoform (I have lately used aristol with good results), and the wound closed, with or without drainage, and just as good results obtained as where the whole organ is removed. It is quite astonishing how large a part of the testicle can be removed in this way without damaging that which is left behind; and so long as even a small portion of the glandular tissue is left in connection with the nervous system, *potentia coeundi* remains to the patient even if sterility from azoöspermism results. Entire excision of the epididymis may be done in this way with only a minimum of damage to the individual. Moreover, this method has the advantage of being applicable to both testicles at the same time, if the conditions require it, while every one, including the patient, shrinks from double castration.

Where the testis is extensively disorganized, the scrotum riddled with discharging sinuses, and there are evidences that the patient's health is being depressed by the drain, castration with removal of the diseased parts of the scrotum is demanded, but it can not be hoped in this way to do more than arrest the discharge, and to that extent improve the general health of the individual. Radical cure can not be looked for. In such cases, the disease has already attacked parts inaccessible to surgical measures. When the cord is diseased, one must also be prepared to see a fistulous tract remain after the operation, so that in such cases one does not even get palliation of the patient's condition to an extent which will justify the operation.

Yet it is in testicular tuberculosis that surgical interference has heretofore been supposed to offer the best promise of success after removal of diseased foci. The greater the length of time these cases are observed after operation, the more clearly it is seen that but little if any benefit has resulted.

# DISEASES OF THE SCROTUM.

By CHARLES W. ALLEN, M. D.

**Anomalies.**—Deviations from the normal scrotum may be either congenital or acquired. Thus, in instances of hermaphrodism, pseudo-hermaphrodism, or pronounced forms of epispadias, as well as in extroversion of the bladder, we have congenital defects, while in asymmetry due to ectopic testicle the condition is gradually acquired.

Complete absence of the scrotal sac has been observed, and an instance of this abnormity has been put on record by Godard (Recherches Tératologiques). We expect, however, always to find at least a fold of thick and furrowed skin occupying the scrotal region, or an infantile development of the organ with lack of hair-supply, even when ectopy of the testicle exists upon both sides. When anorchidia is single, instead of this rudimentary development of the sac there exists, as a rule, only a slight inequality in the two sides, that corresponding to the lacking testis being the less developed. This asymmetry may be acquired quite late in early life.

Often the bag seems to accommodate itself to the single testicle, and by contraction comes to fit it snugly, while the raphé is either obliterated or is much displaced to one side.

Contraction of the scrotum, as well as of the penis, is also a result of certain neuroses of the prostate.

Another anomalous condition due to lack of development is seen in the congenital separation of the two lateral halves of the scrotal sac. Some of these cases strongly suggest by their peculiar configuration the female labia majora. If at the same time congenital defect of the penis is present, hermaphrodism is more or less closely simulated. Absence of testicles often accompanies cleft scrotum. Adhesions sometimes exist between the penis and the scrotum, binding the organs so firmly together as to interfere with genital functions, and an operation becomes necessary to separate the parts.

**Atrophy.**—This condition is found in anorchidia and in ectopy of the testicles. Here the scrotal tissues shrink and contract, adapting themselves to the remaining testicle if one only is contained in the sac. In old age, too, the scrotum often becomes thinned as well as elongated, the base becoming stretched out into a cord-like pedicle, while the hairs and follicles take part in the general atrophy which affects the skin, and pigmentation becomes increased.

**Hypertrophy.**—Simple hypertrophy from mechanical obstruction of the lymphatics is occasionally observed, and may be mistaken for elephantiasis.

Sturgis has reported quite extensive hypertrophy after syphilis. Such enlargement is usually associated with some other manifestation of the disease.

**Abscess.**—Abscess of the scrotum may follow direct injury of the tissues, especially if an open wound is present, permitting germs to enter, or may be secondary to tuberculosis of the testes, suppurating gumma, and occasionally other pathological conditions.

When pus has formed in the scrotum, it should be evacuated early. The process of repair to the tissues, as a rule, goes on rapidly when the scrotum has been damaged by abscess formation, provided all the pathological tissue has been removed; but in the case of tuberculosis a fistulous tract usually remains for a long time. Hæmatocele may result in abscess, if an open wound permits the entry of septic germs.

**Injuries.**—From the exposed position of the scrotum, it not infrequently suffers injury along with its contents, and often, too, is the seat of damage when the testicles escape injury by reason of their mobility.

*Incised and lacerated wounds* may follow falls upon the perinæum, and occasionally one is called upon to treat those which have been self-inflicted. When deep, wounds often expose the testicle, the elasticity of the scrotal tunics permitting retraction. In contusions resulting from horseback exercise, gymnastics, blows, kicks, etc., there is often an extravasation of blood, causing extensive ecchymosis. This variety of wound is quite common.

*Lacerated wounds* may further result from bayonet thrusts or from gunshot wounds, though the latter are rarely seen excepting where the testicles have been injured at the same time. The testes may be laid bare by the scrotum being torn away wholly or in part, and a plastic operation be called for.

*Punctured wounds* from the prongs of pitchforks, falls upon nails or splinters, and surgical punctures not carefully made, offer great chances for infection, and erysipelas, phlegmon, gangrene, and sepsis not uncommonly result. The indication here is for free incision if any signs of sepsis become manifest.

Wounds of the scrotum are frequently produced by the surgeon in operation for varicocele where a portion of the sac is dissected out, or in the procedure for castration; and it is found that here, as in accidental injury, the resulting scars are small as compared with the size of the wound.

Hæmorrhage into the loose dartos spaces, from retraction of the severed arteries, is to be guarded against. The arteries lie near the raphé, and if cut should be at once ligated or compressed with clamp forceps. In injuries as well as in operations implicating the scrotal sac the possibility of the presence of hernia and wound of the intestine must not be overlooked. As a rule, the scrotal tissues heal promptly, but a good precaution in operation is to pluck out the hairs or cut them short over the operation-field, that they may not interfere with subsequent repair.

In contused wounds the parts should be brought together as well as may be in front of the testicles and maintained in this situation with antiseptic dressings, so as to secure, in healing, the best covering for these organs. If extravasation has taken place, the treatment must be amplified by the application of cooling lotions, rest, and support of the parts, under which absorption usually takes place.

*Infiltration of urine* may cause injury to the scrotal tissues severe enough to result in sloughing and even loss of life from blood-poisoning. The dartos readily sloughs notwithstanding its great vascularity. The indication is for early and free incision, while the strength is kept up with iron, quinine, and other tonics.

*Burns* of the scrotum are comparatively rare. If the degree of heat has caused sloughing, the same treatment is applicable as in death of the parts from infiltration of urine. In either case, if extensive loss of tissue has occurred, a plastic operation may be called for.

*Tight strapping* may result in such injury to the scrotum that sloughing will occur.

*Frost-bite*, likewise, may be followed by mortification of an area of scrotal tissue.

**Fungus of the Scrotum.**—Wounds of the scrotum are occasionally, though rarely, followed by a superficial fungous growth. Usually the wound is of such a nature as to permit of partial hernia of the testis, and through neglect in applying suitable sutures after replacing the testicle the surface of the albuginea presenting at the open wound becomes granular. A permanent cicatrix may result, binding the scrotum to the testicle. Benign superficial fungus may be likewise induced by the irritating effect of secretions which are permitted to flow over the skin or remain upon it, causing redness and infiltration, with nodular formation and subsequent vegetating outgrowth or fungus. It is to be treated by thorough cleanliness, cautery, and cicatrizing dry dressings.

**Œdema.**—In general anasarca from heart, kidney, or other disease, the scrotum seldom escapes, and, indeed, it is often here that the fluid in the tissues first manifests itself. Œdema of the scrotum usually attains comparatively large proportions, because of the abundance and looseness of the subcutaneous connective tissue.

Localized œdema of the scrotum may take place from causes which constrict the apex of the sac, such as occur in hydrocele; and this is often seen in the hydrocele of young children, while œdema may occur in youth, from slight causes, in the absence of hydrocele.

Obstruction of the return circulation from enlarged glands in the groin, syphilitic infiltrations, infiltration of urine, etc., may result in a more or less temporary dropsy of the parts.

This, too, may be caused by the rupture of a hydrocele, or it may be due to acute suppuration of the tunica vaginalis.

Acute anasarca of the scrotum, if due to general debility, has a pink-colored surface; while œdema, as usually seen, has a transparent, waxy look.

Œdema also accompanies elephantiasis, erysipelas, eczema, ivy-poisoning, and other skin diseases.

The diagnosis of this condition from that of extravasation is made by the perinæum being implicated in the latter.

Hard or soft œdema, such as is occasionally seen upon the skin in association with urticaria, or as an independent affection, I have not observed upon the scrotum, nor have I found cases recorded. So-called acute œdema of the scrotum is probably, in the majority of cases, a phlegmonous or erysipelatous condition, coming on in the course of certain infectious diseases. Inflammatory œdema, in which the skin becomes stretched, glistening, and red, is seen at times in tuberculosis of the testicle.

**Emphysema.**—In complete subcutaneous emphysema the scrotum becomes inflated with gas, at times to an enormous extent, just as we have seen that very extensive œdema of these parts is the rule in general anasarca. Emphysema of the scrotum alone may be occasionally observed as the result of local injury from the puncture of a trocar or accidental wound, and the condition may be brought on intentionally for purposes of deception—a fact well to be borne in mind in obscure cases. A peculiar crackling of the tissues is called forth by manipulation of the parts. The percussion note will be resonant.

Emphysema may accompany gangrene of the tissues. Verneuil makes two classes of the affection: 1. Benign aërian, subcutaneous or serous pneumocele, due to injury—(*a*) local; (*b*) remote, as in wounds of the air-passages and neighboring cavities of the head and neck, intestinal wounds, etc. 2. Malignant bacterial pneumocele, due to phlegmonous inflammation, implicating the genitals or regions adjacent to them. Benign cases recover spontaneously, or after puncture. The malignant forms are grave and require energetic measures, including incision, drainage, disinfection, and at times castration.

## CUTANEOUS AFFECTIONS.

**Eczema.**—This is one of the most frequent, most tenacious, and most discomforting of the cutaneous troubles which affect the scrotum. It occurs often in subjects of gout or rheumatism, and sometimes in diabetics, though it may develop in the absence of any diathesis.

It may present itself in the acute or chronic form, and be of the dry squamous variety, lichenoid, rhagidiform, or exist as an eczema rubrum, crustosum, or seborrhoicum.

The itching is usually most intense, and in the lichen-like form is almost unbearable, especially at night. When deep fissures form, the pain and burning become very distressing. There is considerable thickening of the skin from infiltration, and the volume of the sac is often much increased, while contraction of the dartos may markedly increase the depth of the furrows. The skin may be uniformly reddened or present a raw-looking surfaces from which a sticky discharge takes place. Unless the greatest cleanliness is observed, the odor from such an oozing eczema becomes very offensive.

**Treatment.**—Acute cases require soothing, slightly astringent and antipruritic dressings, while the chronic demand stimulating applications, especially when the infiltration is marked. For the former, equal parts of aqua calcis and oleum lini, to which may be added five per cent or more of iodoform, dermatol, aristol, europhene, or two per cent of resorcin, meet the requirements for most cases. Zinc oxide, bismuth or lead in ointment to which one per cent of menthol, five of naphthol, or carbolic acid are added, suffice often to allay the itching and hasten the cure. When the skin has become much thickened and thrown up into ridges so that it must be put upon the stretch to bring into view the parts between them, and especially when this condition is a chronic one, such strong applications as the liquor picis alkalinus recommended by Bulkley, or the caustic potash solution in strength of half a drachm or more to the ounce as suggested by Taylor, will often be of benefit; strong nitrate-of-silver solutions may also be employed in similar chronic cases.

In less severe instances, inunction of fatty substances such as lanoline, vaseline, or simple ointments, perhaps with the addition of a small percentage of tar or oil of cade, may suffice, while in other cases the diachylon ointment of Hebra will give good results.

Internal medication should be directed to any diathesis which may exist.

In the dry and papular varieties arsenic will be found very useful, the dose being gradually increased until physiological effects begin to be noted.

General tonics, including cod-liver oil, sirup of the iodide of iron, etc., are to be given according to the requirements, just as in eczemas of other regions, and diet must not be neglected.

**Eczema Marginatum.**—Though usually beginning upon the inner surface of the thigh, and only attaining the skin of the scrotum by invasion after extending over the fold of the groin, eczema marginatum occasionally appears to develop first upon the lateral surface of the scrotum, and subsequently spreads to the contiguous surface of the thigh.

Certain occupations, such as that of cavalryman and riding-master, favor not only the development of the affection but its rapid spread and tenacity. The natural moisture of the parts thus increased, and especially in warm weather, presents the conditions favorable to the growth of the parasite on which the disease depends. It often proves most rebellious to treatment for the same reason.

It is to be distinguished from ordinary eczemas by the abrupt termination of its margin in the healthy skin, by the somewhat infiltrated border, the comparatively slight itching, and the almost constant presence of a characteristic area upon the adjacent thigh. The chief subjective symptom is pruritus, and this is not always pronounced.

**Treatment** is best carried out by keeping the parts clean and free from perspiration, while strong parasiticides are employed. In recent cases the compound tincture of iodine is efficacious, while in the more chronic, mercurials in strong percentage, or, probably best of all, ten per cent of chrysarobin in lanoline and lard are recommended.

**Pruritus.**—Itching of the scrotum is the most frequent of all symptoms referable to this organ, and even after excluding the pruritus consequent upon and a symptom of eczema, there still remains a large number of cases of *pruritus*, a disease *per se*. While in pruritus of the general surface from any cause the scrotum rarely if ever escapes, there still are forms of pruritus which affect the scrotum exclusively or especially. Thus pruritus scroti may be spoken of as an exclusive affection with as much propriety as one speaks of pruritus ani.

The etiology of pruritus the disease is in many instances obscure, while in others the rheumatic or gouty habit is plainly at the bottom of the trouble, especially in men past middle life. Here exacerbations of itching are observed to follow those excesses which we might anticipate would precipitate an attack of the constitutional disease.

Pediculi as the exciting cause of pruritus must be carefully excluded, and the itching in eczema must likewise be differentiated from true pruritus. This is not always as simple a matter as it would seem, for the tissue changes due to the irritation of scratching and mechanical injury might readily be regarded as changes produced by eczema.

Pruritus senilis affecting the whole surface often proves very troublesome in the region of the scrotum, and the skin becomes excoriated, pigmented, and stretched from the constant irritation of scratching, friction, and pulling to which it is subjected. In some cases pruritus of the scrotum leads to masturbation, and the patient is not readily broken of the habit until the pruritus is cured.

Occasionally a variety of pruritic affection is encountered in which the itching may be described as subdermic. There is little or no real itching of the surface, but a feeling of formication beneath the skin, coming on especially when the clothing is removed at night. It is relieved not so much by scratching as by rubbing the walls of the sac together or dragging upon them. This condition may persist for years without causing any appreciable changes in the skin or evidences of its existence upon the surface.

To treat pruritus of the scrotum successfully, any disorder of the system on which it may depend, such as diabetes, rheumatism, etc., must be sought for and treated. Locally, antipruritic remedies, such as tar, aconitia, menthol, as well as mercurial preparations, are of much use, but in all cases the patient should be instructed to avoid scratching as much as possible, for in most instances the condition is only intensified by it, and the relief thus afforded is only temporary.

Turkish baths, sulphur baths, and sometimes sea-salt baths are beneficial, and I have at times seen relief from strong nitrate-of-silver solutions painted over the whole surface. As we know from the treatment of orchitis, the scrotal skin is very tolerant of silver, and one or even two drachms to the ounce can be painted over the surface.

**Pediculosis.**—The special pediculus which by its presence and bite causes the intense pruritus in this affection is the so-called pediculus pubis or crab-louse.

The diagnosis is readily made (though close inspection is sometimes required) by the presence of brownish spots upon the surface near the base of hair-shafts, and of ovoid spheres upon the hairs themselves. The former are the parasites and the latter their eggs or hatched-out shells.

Treatment is best carried out by means of mercurial washes or ointments, applied not only to the scrotum but to the neighboring region, while the whole surface of the body, including the brows, eyelids, and axillæ, are searched for pediculi. If but few lice are found and none elsewhere, they may be removed mechanically with forceps, and the nits stripped off the hairs in the same way. In order to avoid the disagreeable features of mercurial ointment, an ether or chloroform spray may be directed upon the parts, or one of the non-mercurial parasiticides, such as tincture of delphinium or benzine, may be applied.

**Herpes.**—Chronic recurrent herpes of the scrotum has been reported by Dr. Flatau (Deutsche med. Wochenschrift, No. 22, 1891) in connection with herpes of the mouth and penis. The affection shows a decided tendency to recur, and, while the etiology is not known, it is supposed to be a neurosis. Herpes of the scrotal skin incidental to zoster of neighboring parts is rarely observed.

**Lupus** is not often seen upon the scrotum. When it does occur, it is the same affection and must be treated in the same way as lupus located elsewhere. The lesions, as a rule, assume a ringed form, and to secure good results the tissues for some distance beyond the ring must be destroyed or removed, just as in treating cancer.

**Psoriasis** in rare instances may be localized upon the scrotum.

After disappearance of the lesions, pigmented spots may remain for a long time at their site, probably because of the tendency on the part of the scrotum to become pigmented after any irritation.

**Dermatitis** may arise from any local irritant or may follow the ingestion of certain drugs. It is not infrequently due to the use of mercurial ointment for the cure of pediculosis, and is at times found after the employment of strapping for enlarged testicle, due to the irritation of the plaster. Those who suffer from ivy-poison often have the scrotum implicated in the dermatitis along with the face, hands, and other parts. Some persons who possess an idiosyncrasy as to quinine show a special tendency to dermatitis of the scrotum after the use of the drug, while in other cases the first manifestations of irritation are noticed about the prepuce and glans penis. Arsenical eruptions localized upon the scrotum have been reported as occurring among men whose work brings them much in contact with arsenic. The treatment is that for similar dermatitis elsewhere located, and is usually simple and successful when the exciting cause has been once eliminated.

**Intertrigo** affecting the scrotum and contiguous region of the thigh is especially prevalent in childhood, from slight causes. In the adult it is for the most part seen in the army and in those who walk much or ride horseback. It is especially prone to attack fleshy men and those of uncleanly habits. In the former it often proves a very obstinate condition.

To secure prompt recovery scrupulous cleanliness is necessary, and the frequent removal of all offending secretions which might prove irritating. Resorcin ointment in two-per-cent strength, with twenty-five-per-cent lanolin, usually gives excellent results. A suspensory bag should be worn, and the scrotum prevented from contact with the skin of the groin and thigh.

Simple dusting-powders are useful, and should be continued after all redness has disappeared.

**Molluscum Contagiosum.**—This disease quite commonly affects the scrotum, and at times this is the sole region on which the molluscum growths are to be found, although the penis is most apt to show them at the same time. When large and grouped, the diagnosis lies between this affection and sebaceous cysts. Treatment by scraping out with the curette and applying nitrate of silver to the base, or simply washing with a 1–2,000 bichloride solution, suffices for a cure.

**Pityriasis versicolor** occasionally, though rarely, occupies the same location upon the scrotum and thigh as an eczema marginatum. It is much more readily cured than the latter, often requiring no more than a few applications of tincture of iodine.

**Scabies** finds one of its most frequent locations upon the genitals. It may be readily conveyed to the scrotum and penis by the hands. An eczema of the scrotum may result in neglected cases.

**Sebaceous Cysts.**—Cysts of the scrotum sometimes attain the size of filberts or even larger dimensions, and when occurring in groups present quite a noticeable deformity. They are for the most part situated in the upper portion of the sac. Treatment consists in incision of the skin, enucleation of the cyst with its walls unruptured, or, if this fail, evacuation of the contents and scraping out the sac with the curette, followed by free antiseptic washing. Small cysts can be squeezed out between the thumbs after incision of the skin.

**Pigmentary Affections.**—The scrotum is very apt to become deeply pigmented after persistent scratching, or in fact after any irritation, and at about the time of puberty, notably in dark-skinned persons, a natural increase in the pigmentation takes place, amounting in some instances almost to blackness.

*Vitiligo* is occasionally seen in association with the same disease, so often found upon the penis.

Treatment has little effect upon this condition. Should advice be sought on account of the pigmentation of chloasma, a strong solution of bichloride (five grains to the ounce), to blister and cause the skin to peel, offers the best chances of success. Pyrozone, the name given to a fifty-per-cent solution of peroxide of hydrogen in ether, will effect the same purpose. A drachm each of ammoniated mercury and bismuth subnitrate to the ounce of vaseline has acted well in some instances.

**Ulcers.**—Almost invariably ulceration of the scrotum is chancroidal or syphilitic. Tuberculosis of the testicle as well as hæmatoma, various forms of injury, etc., may implicate the scrotum secondarily.

Gross has described an *ulcère soudain* which in the short space of twenty-four hours destroyed the scrotum of a fifteen-day-old child down to the vaginalis. The nature of the process is not given, but it would seem probable that the condition was akin to the rapidly ulcerating stomatitis in childhood usually called noma.

**Erysipelas.**—Erysipelas invades the scrotum by spreading from some other region much more commonly than it starts in the scrotal tissues themselves; still, in injuries, and, as I have observed it several times, after ritual circumcision, the first manifestations of the infection are seen here. Erysipelas migrans in childhood is very apt to involve the scrotum, and the swelling of the tissues becomes very pronounced, while much tension and pain are occasioned. Primary erysipelas of the scrotum may start from a fistulous tract, an excoriation, bite of an insect, or wound of the tissues accidentally or surgically inflicted. It is rare. Erysipelas may be followed by gangrene of the scrotum, and this is probably the origin of many obscure cases in which the cause of the gangrene is not found.

Phlegmonous erysipelas occurs, as a rule, only in the aged and infirm. The scrotum here becomes mottled, marbled, or black, from excessive extravasation of blood. The enlargement is often extreme, and the tumor thus produced is tense and has a smooth, shining surface.

Phlegmon is rare. Any prolonged local irritation causing injury to the surface may cause its development. Thus it is seen to follow the presence of a foreign body in the scrotal wall, the escape into the skin of an injection used for hydrocele, a urinary fistulous tract, the injury of a contusion, or the friction incidental to a forced march. Circumscribed phlegmon is commonly surrounded by a zone of œdema which subsides as soon as the pus is evacuated, and this should be accomplished as soon as it is detected. Fever and insomnia are apt to be the most marked symptoms. In diffuse phlegmonous erysipelas there is great tumefaction and the process is very prone to spread to the perinæum and lower abdominal region, and it would appear that the anatomical conditions which determine the course and limits of infiltrated urine operate in the same way as in the case of phlegmon of the scrotum. This condition may prove rapidly fatal, and in the more benign cases a typhoid state with high temperature and grave symptoms may be present. Even in apparently mild cases all infiltrated areas should be freely incised, the lines of incision cauterized, and antiseptic dressings applied. In simple erysipelas I have found ichthyol in collodion an excellent application. Erysipelas beginning in the scrotum might be prevented from spreading to the general surface by applying an adhesive band firmly about the apex of the bag at the peno-scrotal junction, in such a way as to constrict the lymphatics without making undue pressure on the cord and vessels.

## ELEPHANTIASIS OF THE SCROTUM.

Elephantiasis scroti, with or without implication of the lower extremities, is quite a rare disease in the United States, especially among the native population, being more common among the blacks in the South than elsewhere.

It is more or less prevalent in Egypt, India (Lower Bengal), China, Samoa, Barbadoes, and parts of South America, and appears to flourish best near the seaboard. Two forms are usually considered to exist—the firm, *hypertrophied* variety and the soft *lymph scrotum*, also called at times pseudo-elephantiasis, and by Rindfleisch *pachydermia lymphangiectatica.*

Dr. Fenger, of Chicago, believes that the so-called lymph scrotum is only the early stage of elephantiasis, in which the tissues are still soft and œdematous, permitting the formation of thin-walled transparent bullæ over the surface of the tumor. These bullæ may burst, allowing a milky fluid to escape, and be attended with a temporary decrease in the size of the growth. Enlargement of the lymphatic glands is a common accompaniment, and if an abraded surface permits the entrance of pus microbes suppuration may take place. In the succeeding stages the skin becomes nodular and leathery, and there is a formation of crusts and scales.

The two varieties resemble each other greatly, if they are not identical, and clinically there is no distinction to be made between them. Manson has indeed shown that elephantiasis, lymph scrotum, and chyluria are all related and due to a common cause—the *filaria sanguinis hominis.* The scrotum in this disease may attain enormous proportions and prevent locomotion by its weight, which may equal that of the rest of the body, or may be of even greater weight. In such a case one might speak of an operation as being undertaken to remove the patient from the tumor!

Dr. Browne, surgeon to the General Hospital in Madras, successfully removed a growth which measured over six feet and a half in diameter, the urine being passed from an opening at two feet and a half from the pubis. The weight was found to be one hundred and twenty-four and three quarter pounds.

Elephantiasis of the scrotum usually begins as an induration of limited extent in the more dependent portion of the sac, and gradually extends by infiltration of neighboring tissues, slowly at first and then more quickly; but while its development may extend over a period of years, the increase is always more rapid than in elephantiasis of the extremity. It is not contagious nor hereditary, and, although endemic in the countries mentioned, sporadic cases may occur anywhere. It develops rarely in youth or advanced age, the majority of instances beginning between the ages of twenty and forty. The relative frequency of scrotal elephantiasis is shown by the statistics of Araujo (Atlas des maladies de la peau, Rio de Janeiro, 1887) to be about five per cent, or twenty-one instances in four hundred cases of the disease observed. Of these, two were of the scrotum alone, fourteen of the scrotum and penis, and five of the scrotum and one extremity.

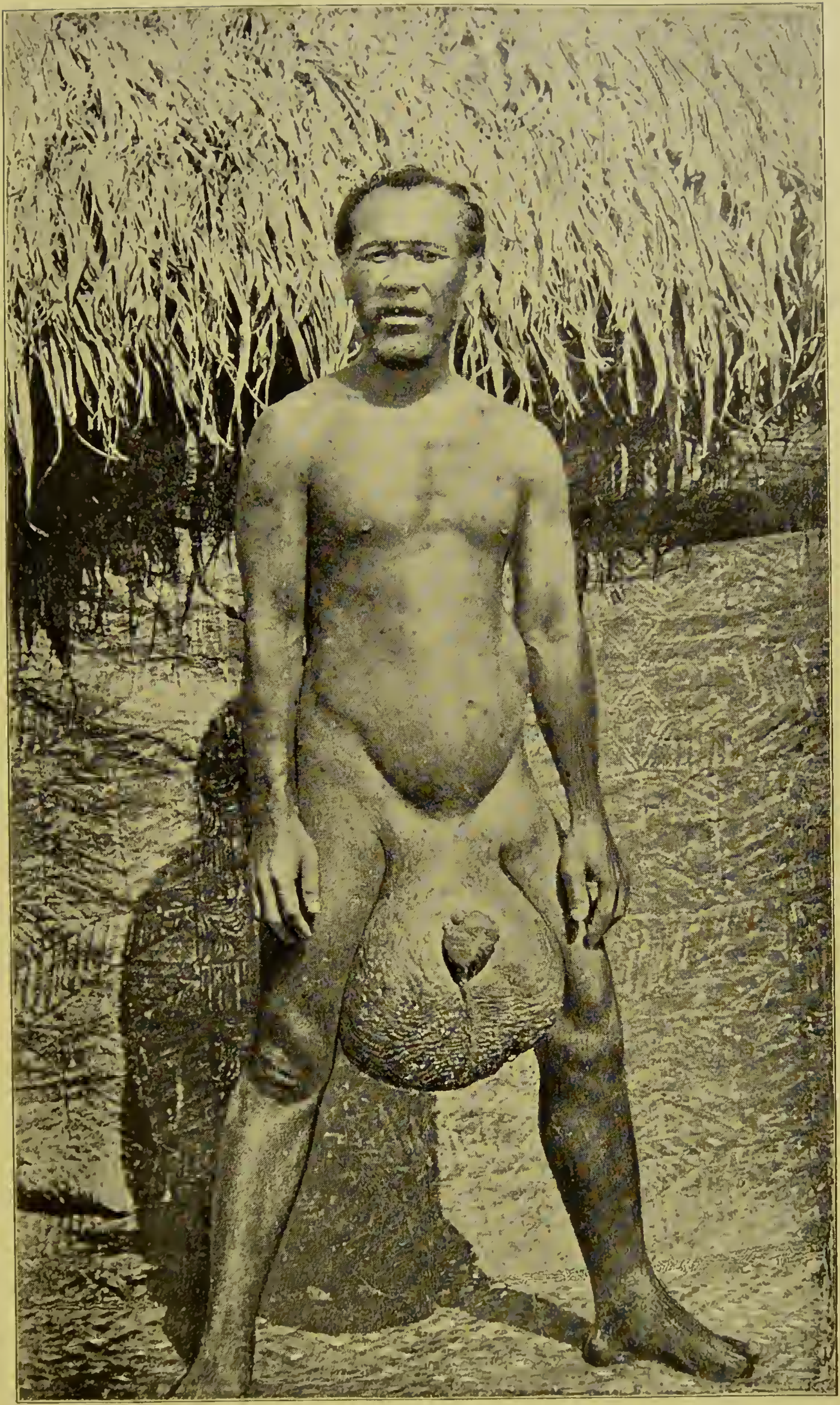
**Symptomatology.**—There are few subjective symptoms attending the onset of elephantiasis. It is usually a painless affection, but at first pains in the lumbar region, in the testes or groins may be complained of, together with swelling of the spermatic cord. The first manifestations of the disease may appear after an attack closely resembling erysipelas, and such attacks may recur during its course, or simply erythematous redness with swelling, and anæsthesia of the skin may occur at intervals. The temperature is usually somewhat elevated, and recurrent exacerbations of fever, attended by enlargement of the scrotum, are the rule. This increase in size at irregular periods decreases again when the temperature falls, but each succeeding attack leaves the parts permanently larger than the last. A lymphorrhœa or serous exudation, attended by the production of bullæ over the surface, may occur, and the skin gradually assumes a thick and rough character. The sebaceous glands and hair-bulbs atrophy, and the hairs fall out. The penis gradually becomes lost to view, and a depression forms in the tissues corresponding to the orifice of the urinary canal.

When the growth has reached a large size it begins to cause annoyance by its weight and bulk, which render locomotion difficult, as well as to produce in almost all cases a certain mental distress. The accompanying plate, taken from Dr. Morrow's collection of original photographs, illustrates the latter condition. The rough and uneven nature of the surface, together with wart-like elevations, are well shown.

**Pathology.**—All the tissues are hypertrophied as a result of inflammation and occlusion of the lymphatics.

The chief pathological change found is an excessive connective-tissue growth. Microscopical examination of a scrotal tumor removed by Dr. Fenger showed thickening of the epidermal and papillary layers. The epithelial cells were normal in shape and size. Thick bundles of non-fibrillar connective tissue and occasional connective-tissue corpuscles of normal size and shape were found. There was enormous thickening of all vessels, the small veins being five times the normal size. The thickening of the wall was mainly in the external coat, the endothelium not participating. Leucocytes were present in the perivascular spaces, with islands of young granulation tissue. There was no enlargement of the lymph spaces or of the lymphatics, but, according to the observer, some of the islands occupied by embryonal cells were lymph-vessels or spaces in a state of plastic inflammation—a view which seems very probable. There may be increase in the fatty as well as in the areolar tissue, and endoarteritis as well as periarteritis and phlebitis may be present.

**Etiology.**—The primary cause of elephantiasis in most cases has been shown by Manson, Lewis, Bancroft, and others to be the presence of the *filaria sanguinis hominis*, and this view is shared by Maitland in his recent work on Elephantiasis and Allied Disorders.



Elephantiasis of the Scrotum (Morrow.)

Manson believed that all the phenomena of the disease could be explained on this theory. Lewis (Lancet, September 20, 1877) found an adult filaria worm in a lymphatic vessel of a scrotal elephantiasis. The *filaria Bancrofti*, as it is sometimes called, is a thin, white worm three to four inches in length and of the thickness of a hair. It is capable of laying thousands of eggs. It is thought probable that inflammation may be caused by the chemical products of the excretions of these worms, and in non-epidemic regions that any irritative inflammation, such as that produced by erysipelas or syphilis, may have the same result.

The secondary cause is obstruction of the lymphatic channels either through the production of embolism, by the filaria itself or its ova, or by the occurrence of inflammatory obstruction. Mapother (Philadelphia Medical Times, November 15, 1887) explains the frequency of scrotal implication on the theory that the lymph here has to rise from such a dependent organ against the force of gravity. When obstruction is complete, according to Maitland, the firmer form of elephantiasis results, and, when incomplete, lymphorrhœa and lymphatic varix are produced.

Enlargement of the lymphatic glands often precedes the development of the disease, and this is thought by some to have an important etiological bearing on its production.

It is not yet settled that all cases have the same etiology, and many believe that any condition giving rise to lymphatic obstruction and lymphangitis is capable of producing elephantiasis in the absence of filaria.

**Diagnosis.**—Elephantiasis can only be confounded with other diseases in the early stages. The slow development of the swelling, the exacerbations and absence of marked symptoms pointing to any other condition would suggest this disease, especially in tropical regions. Confirmatory evidence would be furnished by the discovery of the *filaria sanguinis hominis* in the blood. It has no connection with lepra, though lepers occasionally acquire it. It is to be distinguished from simple hypertrophy, œdema, and fibroma.

**Prognosis.**—This disease must be looked upon as benign, having little effect upon the general system and little influence upon the expectancy of the individual, not materially shortening life. The prognosis, so far as operation is concerned, is excellent, especially in recent years.

Kocher's statistics (Die Krankheiten der Männlichen Geschlechtsorgane, Deutsche Chirurgie von Billroth und Leucke, 1887) give—

27 per cent mortality for 61 cases (Fayrer).
$9\frac{1}{2}$ " " " 21 " (Ballingall).
5 " " " 161 " (Esdaile).
$3\frac{3}{10}$ " " " 61 " (Manson).
$1\frac{1}{2}$ " " " 138 " (Turner).

Maitland gives the mortality in the Calcutta Medical College Hospital as 18·2 and 17·7 per cent from published statistics, but it is said that more recent statistics bring the rate down to only four per cent. In correction of the above statistics, Dr. Fayrer has recently written to the Indian Medical Gazette, stating that his published reports show one hundred and ninety-three cases operated upon, with thirty-five deaths, or a little over eighteen per cent mortality instead of twenty-seven per cent. These cases were operated in the pre-antiseptic epoch beginning with the year 1859.

Turner's report was made in the Glasgow Medical Journal of June, 1882.

For a good prognosis regarding recurrence after operation all diseased tissue must be carefully removed. In rare instances atrophy of the testicles has been observed, but in most cases the genital functions are not interfered with, and impotence does not follow. In view of this fact an effort should be made in operation to save the penis and testes, as can be done in most instances without much difficulty. Hydrocele and hernia complicate a certain proportion of cases. Suppuration in lymph scrotum is rapidly fatal at times, especially in those of enfeebled constitution.

**Treatment.**—The early management of a case of developing elephantiasis includes antiphlogistic measures before the occurrence of much hyperplasia, together with pressure made by means of elastic bandages or strapping carefully applied, rest, and antipyretics. If there is anything in the history or appearances that suggests syphilis, mercurials may be advantageously applied locally, while the iodide of potash is given by the mouth, and this form of medication has in fact been found beneficial in the absence of any specific taint.

In the febrile attacks quinine and arsenic have been found useful, and change of climate is often very beneficial. Many cases are never seen by the surgeon until the tumor has attained a considerable size, and then the knife has been considered the only resource. The rule of the older surgeons was to make no attempt to save the genitals in tumors weighing over fifty pounds, but this rule should never be followed. In none of Turner's cases was the penis sacrificed, and in none were both testicles removed.

The testes, if dissected out and left lying upon the perinæum, usually draw up into place and become covered over with granulations. If the tunica vaginalis is hypertrophied, the rule is to remove it along with the growth. Where practicable, flaps should be made to cover in both penis and testes, or, in fact, a new scrotum produced by plastic operation. Fenger advises a median and two smaller lateral flaps, the median for the penis, and the latter to meet a single broad posterior flap and cover in the testes.

The chief source of danger and annoyance in the operation is hæmorrhage. The vessels are numerous, large, and diseased, and success depends very largely upon the thoroughness with which their ligation is attended to. In a twenty-two-pound tumor removed by Fenger sixty ligatures were applied, and more than this are often required for larger growths.

Formerly soft twisted rope was mostly employed to constrict the pedicle and prevent hæmorrhage, and Lister's tourniquet has been used to compress the abdominal aorta. The elastic constrictor has also been in vogue, but it is liable to slip and has therefore fallen into disfavor. The best method of controlling hæmorrhage appears to be by means of the Turner clamp (see Glasgow Medical Journal, June, 1882, for illustration). It must be applied to the topmost portion of the pedicle after the presence of hernia has been carefully excluded. After removal of the tumor one end of the clamp can be loosened at a time, thus giving opportunity to ligate the vessels slowly and make the operation bloodless.

Electricity by means of the constant current is well spoken of by Liebig and Rohé (Practical Electricity in Medicine and Surgery, Philadelphia, 1890). It surely seems a rational means of treatment in cases not too advanced, and one which might render cutting operations much less frequently necessary. Silva Araujo, who has probably had the most extensive experience with electricity as a means of treating elephantiasis, says that while this method requires the greatest perseverance and patience, it is always beneficial if applied regularly in suitable cases. The induction current, by stimulating the vessels, increases the circulation of both blood and lymph; and while the continuous current acts as a solvent of the masses of connective tissue, the former determines a rapid absorption of the products of this solution. A combination of these currents has hence been found most useful.

Electrolysis by means of needles introduced into the tissues has also been used with advantage. From three to five needles made antiseptic are connected with the negative pole, while the positive is applied to some portion of the body's surface. Six elements are employed to begin with, and this is gradually increased to sixty. Electricity can thus be used under either of these forms separately or in combination.

Dr. Araujo reported a case of elephantiasis of the scrotum associated with chyluria, lymphatic scrotum, *craw-craw*, and erysipelas in the same individual treated successfully by electricity as early as 1877 (Gazeta Medica da Bahia, November, 1877).

## TUMORS OF THE SCROTUM.

Aside from the sebaceous cysts which have been already referred to, cystic tumors of the scrotum are not at all common. Dermoid cysts may occur here as elsewhere, and contain the usual skin elements, hair sebum, and teeth, as well as bone and cartilage. Such a tumor may occupy a position between the testes and occasion no annoyance until it becomes accidentally injured. The diagnosis is made from the history, being that of a congenital tumor, and it is to be distinguished from supernumerary testicle by want of subjective sensation on pressure. The diagnosis is rarely made before operation.

**Urinary Cyst.**—According to Sajous's Annual, vol. ii, 1888, Karewski observed a scrotal tumor the size of the fist, which, on tapping, was found to contain a clear fluid, as in hydrocele. It connected with a urethral fistula, and pressure upon the tumor caused a flow of clear urine from the meatus.

The treatment is excision of the cyst and closure of the urethral fistula.

**Cystic tumors** are rare and of slow growth. They usually develop in obstructed sebaceous follicles, and, next to the scalp, the scrotum is the most frequent situation for them.

I have seen groups of from ten to twenty distended tumors, from the size of a pea to that of a large grape, occupying the upper half of the scrotum and near the middle line. Under the term scrotal cystoma Curling reports a case in which there was an agglomeration of twenty to thirty cystic spheres, with clear, serous contents.

**Hæmatoma** or hæmatocele is the name given to the tumor formed by extravasated blood distending the scrotal pouch. It may be located in the dartoid tissue, in the tunica vaginalis, or in the spermatic cord.

True hæmatocele occurs upon one side of the scrotum only. The skin covering the swelling is more apt to be thinned than thickened, and is more or less tensely stretched. There are fluctuation, crepitation, and a surrounding induration, with lack of translucency. Basil has studied hæmatoma (Thèse de Paris, 1890), and finds the seat of predilection to be the cellular tunic of the dartos. The blood constituting the tumor may be fluid or clotted. It is usually caused by trauma. If the blood is diffuse, we have partial hæmatocele by infiltration; if confined within narrow limits, it is said to be by extravasation, or the two conditions may coexist. Extravasation is frequently between the skin and the dartos. Basil has shown that a serous cavity exists in the subdartic cellular tissue, and this probably often presents a favorable location for the extravasated blood. Symptoms complained of are principally heaviness and dragging in the region of the testicles. There may be ecchymosis of the skin, and this may extend from the scrotum over the thighs, abdomen, and possibly the back.

*Diagnosis* is principally from fibrous tumor. If skin is ecchymosed it is diagnostic.

*Prognosis.*—Absorption takes place, and there is no suppuration unless there be communication with the outer air through a wound by which germs can enter. Gangrene or septicæmia may follow if germs gain entrance. At times the extravasated blood becomes encysted.

*Treatment.*—Place a cushion or pad between the thighs, or apply a wide strip of adhesive plaster across them for the scrotum to rest upon. Use antiphlogistic measures and cold applications, and, if inflammatory symptoms threaten abscess formation, open freely.

**Angeioma or Vascular Tumor** is usually congenital. The attention is, however, not directed to it until some injury or other exciting cause stimulates a growth which is peculiar in being intermittent, and attended with some inflammatory symptoms. The tumor may be of firm consistence, or there may be irregular, soft spots over its surface due to the presence of small serous cysts.

*Treatment* by excision after ligature.

**Fibroma** is very rare. A case is reported by Ferguson. It occurs as a hard, lobulated, and encapsulated growth, which under the microscope is found to be composed of fibrous or fibro-cellular structure. Such growths may attain a weight of as much as twenty pounds. They are especially seen in old men.

*Diagnosis* is to be made from hæmatoma, enchondroma, elephantiasis, and cancer.

*Treatment.*—By removal, as in elephantiasis.

**Enchondroma** is also very rare, but instances have been described. The tumor is hard, containing cartilaginous lobes and possibly bone deposits, and may weigh five or more pounds.

**Lipoma** is of interest and importance from the fact that the testicle at times becomes imbedded in it and may have to be removed. It is rare, and seldom attains a large size. Kimball has reported an instance in which the growth weighed two pounds. When small it may simulate a supernumerary testicle. It may have its point of origin in the spermatic cord.

**Epithelioma.**—Epithelial cancer of the scrotum is the form of carcinoma usually encountered. It commonly begins as a warty growth upon the surface, which like similar growths elsewhere may remain as an apparently benign affair for a term of years until some irritation or injury excites the malignant tendency. In the succeeding stages the growth softens, becomes more highly vascular, is now for the first painful at times, the surface becomes covered with a crust or scab, which falls off, exposing an ulcerating and possibly bleeding surface. A small indurated nodule may first be noticed in the absence of any previous wartlike growth. The development is slow but surely fatal unless excised freely and sufficiently early. Such a growth beginning on the scrotum, according to Taylor's observations, may invade the penis.

This disease was once quite common in Great Britain, and was called chimney-sweep's cancer because of the relative frequency with which it occurred in those following this occupation—the soot being retained in the folds of the scrotal skin until an irritation was produced which led to thickening and subsequent cancerous growth. Now that chimneys are no longer swept in the old way the name has lost its significance here, but according to Volkmann, those who work in the coal-tar products, paraffine, etc., and according to Andrews, those occupied as smelters, are liable to this form of cancer.

Encephaloid carcinoma and scirrhus are rarely observed. The former, if pigmented, is termed melanotic. In any form, if the inguinal glands are implicated they must be dissected out at the time of operation.

A vegetating cancer suggesting in appearance a cauliflower or mushroom, is to be diagnosed from fungus of the testicle. The surface of this form bleeds easily, and the margin of the scrotal orifice through which the cancerous growth escapes is as though pinked.

Sarcoma is extremely rare, both the melano-sarcoma and myxo-sarcoma.

**Tuberculosis.**—Primary tuberculosis of the scrotum has been studied by Rochette (Thèse de Paris, 1885). It is very rare. In tuberculosis of the testes an inflammatory œdema of the scrotal tissues is observed in which the skin is stretched, glazed, and red. The various layers become infiltrated, thickened, and lardaceous, especially about the orifices of fistulæ. When the latter have healed this condition disappears. Occasionally secondary tuberculous infection takes place.

# DISEASES OF THE TESTICLE.

By JAMES BELL, M. D.

## HÆMATOCELE.

**Definition.**—Hæmatocele, by which we mean a tumor caused by the effusion of blood, may occur into the tunica vaginalis (vaginal), into the substance of the testicle (parenchymatous), or into the spermatic cord.

**Etiology.**—It is practically always due to injury, and very often occurs in connection with hydrocele. Blood is frequently poured out into the cavity of the tunica vaginalis after the tapping of a hydrocele, generally from the wounding of a vessel by the instrument, but occasionally, perhaps, from the removal of the pressure of the hydrocele fluid upon the vessels of the vaginal walls. Other causes are blows upon the testicle and strains, as in heavy lifting.

Predisposing causes are diseased conditions of the walls of the blood-vessels, hæmophilia, etc. Hæmatocele of the substance of the testicle (parenchymatous) rarely, if ever, occurs alone. It is usually connected with, and of secondary importance to, hæmatocele of the tunica vaginalis.

**Symptoms.**—Hæmatocele of the testicle appears as a globular uniform tumor, largest below, painless, except when the tension is great, as in a very large tumor or where the effusion is parenchymatous ; opaque, heavy and resistant to the feel, when recent. Inflammatory thickening of the tissues soon takes place when the tumor becomes dense and hard, and may be mistaken for a neoplasm of the testicle. The inflammatory process which first involves the tunica vaginalis extends to the scrotal tissues, and if acute may end in abscess, especially in aged or debilitated subjects. More frequently, however, the process is of a more chronic nature, and may continue for months or years. In such cases the tunica vaginalis becomes greatly thickened, dense, and hard, and loses to a great extent, or altogether, its character as a serous membrane. Wasting of the testicle may take place, especially if hæmorrhage has occurred in its substance, and diagnosis becomes exceedingly difficult even after an exploratory incision has been made. The irregular sac will be found to contain a brownish, greenish, diffluent substance, often described as resembling coffee-grounds and sometimes contains cholesterine. This is, of course, the remains of the degenerated blood-clots.

**Diagnosis.**—In recent cases, and where a reliable history can be obtained of the sudden development of the tumor after injury, diagnosis is sometimes easy. When an acute, intense inflammation has developed and more particularly in the chronic cases, diagnosis is difficult and often impossible. It is well to remember that the testicle ordinarily preserves the same relation to the tumor as in hydrocele, lying posteriorly and toward the bottom of the scrotum, where it may be distinguished from the bulb of the tumor by yielding its characteristic sensation on pressure.

**Treatment.**—In recent cases of slight or moderate effusion, rest in bed, elevation of the testicle, restricted diet, and free evacuation of the bowels daily, will usually be found sufficient. If seen early, while the hæmorrhage is still progressing, ice may be applied, and at a later period absorption may be hastened by hot applications containing acetate of lead and opium, to relieve pain if necessary. In very exclusive effusions the sac should be laid open, the clots removed, and bleeding points secured. This operation, performed with modern surgical precautions, is simple and safe, and, in addition to greatly hastening recovery, it is the surest method of preserving the integrity of the testicle. When suppuration has occurred, free incision, washing and draining the cavity are of course indicated.

In the chronic cases free incision and drainage are also indicated, but care must be taken not to injure the testicle, which is often difficult to recognize, unless, indeed, it be already disorganized, when it should be removed, with the thickened and altered tunica vaginalis.

**Hæmatocele of the Cord** is a very rare affection, but one which may occur in good health and independently of any disease of the genital organs. Its causes are direct violence and sudden and severe strain, as in lifting a heavy weight. Curling mentions that Mr. Pott has related three cases, all of which occurred in this way (from strain); one of these occurred in a young man while straining at stool. In either case the blood is effused into the tissues of the cord, producing a fusiform swelling, which in cases caused by direct violence may be obscured by effusion of blood into the surrounding subcutaneous tissues.

**Diagnosis.**—Such a tumor suddenly developed, in this situation, after injury or straining efforts, may be mistaken for a hernia. Careful examinations will, however, fail to discover any of the characteristic signs of hernia; and a few hours' delay, during which the hæmatocele will become hard and tense, with probably ecchymoses into the surrounding parts, will greatly aid in clearing up the diagnosis.

**Treatment** must be conducted on the same principles as in hæmatocele of the testicle; encysted hydrocele of the cord may be converted into a hæmatocele, and should be dealt with in the same way as an ordinary hæmatocele of the tunica vaginalis.

**Free Bodies in the Tunica Vaginalis.**—Free bodies have been found in the tunica vaginalis, usually in connection with hydrocele, of which they were probably the cause. These bodies, which are usually small and cartilaginous, and sometimes contain bone elements, correspond to the "floating cartilages" so often found in the synovial sacs, especially of the knee-joint. They have probably a similar origin.

## ANOMALIES OF THE TESTICLE.

**Absence of the Testicle.**—Cases of congenital absence of one or both testicles (as well as of supernumerary testicles) have been recorded from time to time, but the actual occurrence of such conditions is very difficult of demonstration. Apart, however, from monstrosities, and cases in which the genital system is irregularly or imperfectly developed as a whole, there would seem to be occasional instances of congenital non-development of one or both testicles. One of the best-authenticated examples of this condition is the case reported by Fisher, of Boston (American Journal of the Medical Sciences, vol. xxiii, page 352), which has been quoted by most writers on this subject. In this case the deficiency was noted at birth and confirmed by dissection after death, the man having died of pneumonia at the age of forty-five. It is related that this "man's voice remained unchanged at puberty, he had no beard or whiskers, the skin of the pubes and scrotum was without hair, the penis was not larger than that of a boy ten or twelve years old, and the scrotum was contracted in size"; also that "he never exhibited any amorous propensities or desire for female society" (Curling). Irregular and imperfect descent of the testicle as well as atrophy of the organ must be taken into account in any given case where dissection proves its absence before assuming that such absence is congenital.

**Supernumerary Testicles.**—A considerable number of cases have been reported of men who are said to have had three or four or more testicles. In very few of these cases, however, was any attempt made to demonstrate this fact by post-mortem dissection, and it is doubtful if it has ever been clearly demonstrated, although Curling quotes Blasius as having examined the body of a man thirty years of age who had two testicles in the right side of the scrotum and one in the left. It is tolerably clear, however, that in most of these cases the supposed supernumerary testicle is a small tumor of some kind, such as an encysted hydrocele, epiplocele, omental hernia, fatty or fibrous tumor (the latter is not rare in the epididymis).

A case came under the observation of the writer a few years ago of a man who appeared to have (and who believed he had) two testicles in one side of the scrotum and one in the other. He was confirmed in this opinion by a great many medical men at home, and by at least one eminent London surgeon who had examined him. This man has since died, but no dissection was made post mortem.

**Size of the Testicle.**—The testicles, without doubt, vary considerably in size within natural limits. The mean dimensions of the normal testicle are said by Curling to be one inch and three quarters in length, one inch and a quarter in breadth, and one inch in thickness from side to side. He also states that he has found the ordinary weight of the sound testicle of the healthy adult to be six drachms. The left testicle is generally a little larger and heavier than the right.

**Hypertrophy of the Testicle.**—Hypertrophy of a compensatory character is believed to occur when one testicle has been removed or remains undescended in early adult life. A certain amount of enlargement of the testicles is also observed when sexual intercourse is regularly indulged in after a long period of chastity. This corresponds with the temporary enlargement of the testicles observed in animals during the rutting season of the female.

**Atrophy of the Testicle** has been observed to follow upon a great variety of causes. The following are the most important: Orchitis, resulting from injury or disease, as mumps and gonorrhœa, injuries to the brain or spinal cord, pressure as in varicocele, hydrocele, hæmatocele, the pressure of a truss, etc., onanism, and excessive sexual indulgence, syphilis of the testicles, arrest of the blood-supply, enlargement of the prostate gland, and iodism (the latter doubtful).

Atrophy of the testicle has been observed to occur in cretins and idiots, and has been seen in healthy boys, without apparent cause. Not only is there no reason to believe that prolonged chastity causes wasting of the testicles, but the opinions of the best authorities are that it does not do so. It is admitted, however, that when the functions of the testicles have not been called into use they probably cease to be functionally active at an earlier age.

The writer has observed a case in which the excessive use of tobacco at an early age seemed to be the most probable cause of atrophy of both testicles.

A young man, twenty years of age, came under my care in hospital for stricture of the urethra five inches from the meatus. He had a gleety discharge, and attributed the stricture to a gonorrhœa contracted two years before. He was slightly built and excessively nervous, and the testicles could only be distinguished as the clubbed ends of the vasa deferentia, about the size of an ordinary white bean each. He was, and had been from boyhood, an inveterate tobacco chewer and smoker, and had worked in a tobacco factory from the age of twelve years. He denied having practiced onanism or having indulged too freely in sexual intercourse, and stated that the testicles had always been small, but that they had begun to waste some time before he contracted the gonorrhœa. He had not suffered from orchitis.

**Treatment.**—In the majority of cases nothing can be done; but where the cause can be recognized and removed sufficiently early, the further progress of the atrophic change may be arrested.

**Seat of the Testicle.**—Malposition of the testicle, due to irregular or imperfect descent, is frequently observed. The testicle may remain within the abdomen or be arrested in the inguinal canal or upper part of the scrotum. It is also sometimes found in the groin, the crural region, or the perinæum.

The causes of these abnormalities in descent are variously attributed to peritoneal adhesions, smallness of the abdominal rings, shortness of the cord, and loss of power of the gubernaculum testis. Testicles retained within the abdomen remain soft and undeveloped, and, where both are retained (*cryptorchidism*), the individual is generally, if not always, sterile, although sexual power and appetite usually remain unimpaired or even apparently sometimes increased.

[The observations of veterinary surgeons go to show that cryptorchidism in the horse is always associated with sterility, and that such animals show a restlessness not only in the "season," but all the year round.]

When only one testicle is retained within the abdomen (*monorchidism*), the descended testicle, if normal, is sufficient for procreative purposes.

*Misplaced testicles* outside the abdomen (in the inguinal canal, groin, crural region, or perinæum) are especially liable to injury, but seem to be capable, in some cases at least, of a fair if not full functional development, except when they are retained in the inguinal canal, where the limited space, muscular pressure, and constant exposure interfere with development.

The testicle in an abnormal situation is also liable to orchitis from the ordinary causes, and when this occurs the symptoms are much more severe than when the testicle is normally situated within the scrotum. Orchitis occurring within the abdomen may set up peritonitis, and lead to serious consequences.

**Treatment.**—When the testicle remains within the abdomen, no treatment is indicated. If, however, it comes down at times into the inguinal canal, a truss may be required to prevent its passage through the internal ring. Should the testicle descend with a hernial protrusion, it may be possible to fix it in the upper part of the scrotum while performing an operation for the radical cure of the hernia. This will depend, of course, upon its relation to the hernia and the nature of the adhesions which it has formed with it. When the testicle is accessible, its reposition within the scrotum is a feasible operation, which has been successfully performed in a considerable number of cases.

**Retraction of the Testicle** is generally observed as a symptom in connection with lesions of the genito-urinary organs or in pelvic inflammations. It is due to spasmodic contraction of the cremaster muscle, and is most frequently met with in connection with the passage of a urinary calculus along the ureter or during its presence in the bladder.

A form of persistent retraction is also described as occurring in children, and is said to have followed urinary irritation, a kick upon the pubes or groin, a blow upon the abdomen, etc. (Ashhurst's International Encyclopædia of Surgery, vol. vi).

In addition to the foregoing anomalies occurring in persons otherwise normally developed the vas deferens has been found deficient in some cases near the testicle, in others near its distal end.

Curling also mentions a case (recorded by Geoffroy St. Hilaire) of union of the testicles in the abdomen. The subject was an infant, which was registered as a girl, and died at the age of eighteen months. Dissection discovered a complete hypospadias.

**Injuries of the Testicle.**—When normally situated the testicle is not specially prone to injury. Contusions from kicks and blows, bruises upon the saddle in riding, and from falling straddle legs, are not uncommon, but are very rarely serious. The first effects of such a blow or bruise are a dull, sickening pain and perhaps faintness, which soon pass off. If more severe, hæmatocele or orchitis may ensue, and as a remote result hydrocele or fibroid changes in the organ.

*Incised, punctured, or gunshot wounds* are occasionally met with, and it is important to bear in mind that under proper surgical treatment such wounds do well, and castration is very seldom called for, even in the worst cases. The following case may be mentioned in illustration :

In 1885, a man thirty years of age was wounded by a Winchester rifle bullet, which passed through the gluteal fold of the buttock, the perinæum, and scrotum. When seen, the testicle was found lying outside the scrotum, having been pierced through the center from side to side by the bullet. It was cleansed, and the torn and bruised edges of the wound of exit having been removed with scissors it was returned to the scrotum. A complete and uneventful recovery followed, in spite of the fact that the patient went through a severe and prolonged illness from extravasation of urine due to a wound of the urethra, made by the bullet in passing through the perinæum. When last seen, several months after the injury, the testicle, although greatly reduced in size through loss of substance, was apparently normal, and had not undergone any atrophic or other appreciable change.

# DISEASES OF THE TESTICLE.

### By EDWIN C. BURNETT, M.D.

Inflammatory diseases of the testicle are separable into three divisions according to their anatomical seat, and are named orchitis, epididymitis, and vaginalitis or periorchitis, respectively. Each of these affections may attack the part after which it takes its name either primarily, or, as is oftenest the case, secondarily to an invasion of parts adjacent or remote, and its course may be either acute, subacute, or chronic.

## ACUTE ORCHITIS.

**Etiology.**—True orchitis is comparatively rare. The causes are traumatic, idiopathic, and the propagation of disease of the urethra, bladder, and vas deferens. Inflammation of the testicle and epididymis may arise in a case of ectopia testis, when the testicle is placed in a position that exposes it to external violence, or to the pressure of adjacent parts, as when the testicle has been displaced into the perinæum, or is situated in the cruro-scrotal fold, or, partly descended, is arrested in the inguinal canal. English describes as a special form of violence through which inflammation of the testicle and epididymis may arise, that caused by the powerful contraction of the cremaster muscle, which by drawing the testicle upward and against the outer ring of the inguinal canal, brings about such compression of the organ that the injury results in inflammation of it. I have never seen an inflammation that I could trace to this cause, but I have seen a testicle with an inflamed epididymis retracted as far as the outer ring, and held there with such force by the cremaster as to cause excruciating pain out of all proportion to the amount of inflammation, and I should not hesitate to ascribe the inflammation of a testicle in such a position to such compression, if there was an absence of all other causes. The clinical picture of a case of this kind which he calls orchitis-epididymitis *par effort*, is a strong one and better given in his own words: "The scrotum is swelled, in most cases ecchymosed even into the subcutaneous tissue, seldom any fluid in the tunica vaginalis at first, but mostly as a sequel to the supplementary inflammation. In striking contrast to the insignificant initial appearances in the testicle are the subjective symptoms: swooning, nausea, retching, even vomiting, radiating pains toward the loin and thighs, convulsions, sudden collapse, even ending in death, as in injuries of the peritonæum."

Injuries are much less frequently the cause of orchitis than of epididymitis, but the result is apt to be more disastrous, as the issue is sometimes a total destruction of the gland through pressure of the inflammatory infiltration upon, and consequent fatty degeneration of, the seminal tubules. Sometimes the destruction is brought about through abscess and gangrene followed by atrophy. In gonorrhœal inflammation of the urethra we have an infrequent cause of orchitis, the disease seldom acting directly, as the epididymis is first affected, the inflammation going over to the testicular tissue in rare cases. Kocher quotes cases in which the testis proper was the seat of the inflammation, the epididymis remaining free. Mr. Hutchinson also mentions such a condition, both testes being affected. I have never as yet seen a gonorrhœal orchitis—that is, one in which the gland was primarily attacked. Després attributed the inflammation in such cases to the accumulation of semen through swelling of the excretory tubes, especially the ductus ejaculatorii. If he meant by this the obstruction to the ejaculation of semen at the time of intercourse, I can agree with him as to the probability of such a condition acting as a cause of orchitis. I believe that obstruction to the emission of semen can play a part in setting up an inflammation of the testicles only when there has been undue and repeated sexual excitement on the part of the patient. Urethritis prostatica, prostatic hypertrophy, cystitis, strictures, operations on the urinary and genital organs (catheterization, lithotomy, evacuation of hydrocele, acute and chronic, especially lithotomy in the aged or enfeebled), form frequent causes. Abdominal strain such as occurs in extreme constipation (I have seen one case of orchitis from this cause), heavy lifting, prolonged and repeated sexual excitement without gratification—all act as causes of orchitis and epididymitis.

Owing to the very favorable condition in the secreting part of the testicle for the arrest there of morbific elements circulating in the blood, inflammations arise such as are seen sometimes in pyæmia, variola (Chiari), scarlatina, malaria (Simon, Kocher), abdominal typhus, leprosy (Ziegler), often in parotitis, syphilis, and tuberculosis. In orchitis from parotitis we have the so-called metastatic form, wherein, after from four to eight days of the mumps, the testicle is attacked and an acute orchitis set up. This happens most frequently in young individuals, from puberty on to the age of thirty, though the complication may occur in still younger patients; and, on the other hand, cases are reported in much older persons—viz., from the age of forty to forty-five (Kocher, Curling). The testicle is usually attacked after the subsidence of the parotitis, and at times so soon after as to have given origin to the idea of metastasis. In just as many cases, however, the orchitis develops after an interval of from four to eight days from the disappearance of the mumps, and there appears to be little ground for the application of the term metastasis in the sense of translation of the disease from the parotid gland to the testicle. Ziegler's term, hæmatogenesis, by which he expresses inflammation of the testis dependent upon the cause in question, as well as that from syphilis, tuberculosis, and allied diseases, is, it seems to me, much more in accord with the present status of our knowledge. Cases of orchitis have been reported which have been followed by mumps, and at the time of epidemics of mumps there has been observed orchitis in patients in whom no trace of parotitis could be found. Kocher reports four such cases, and mentions others observed by different surgeons. Finally, come cases of idiopathic orchitis at a time when there has been no mumps. These have been reported as cases of rheumatic orchitis, but by Kocher held, as he also holds orchitis from mumps, to be the result of extension of the inflammation with which the urethra and bladder are sometimes affected in mumps, rheumatism, and gout, along the mucous surfaces to the testicle.

The cases of rheumatic orchitis reported by McLeod and Bouison (Curling) are considered by Kocher not to belong to orchitis, as these authors refer the affection to changes in the tunica albuginea and tunica vaginalis. However, Réclus (Curling) describes a case in a patient, aged sixty-one, suffering from acute rheumatism, wherein the two testicles became inflamed and rapidly atrophied, thus showing that here at least the gland proper was the seat of the disease. Mr. Bell quotes a case of gouty orchitis occurring in a friend, a medical man, who relates the case himself in detail, but who gives a perfect picture of an epididymitis occurring after an attack of cystitis and subacute urethritis, which was followed some time afterward by a swelling of the right knee lasting six weeks, after the subsidence of which the testicle again became painful and slightly enlarged.

Keyes also gives gout as an etiological factor in orchitis, and Sir James Paget (Curling) reports several cases of orchitis occurring in gouty patients. Of the above-mentioned general diseases the one most frequently causing orchitis is the mumps. Finally, acute orchitis, and epididymitis also, may occur from causes not demonstrable, especially in little children (Kocher). Fleming saw in a child fourteen days old, and otherwise apparently healthy, an acute, painful swelling of the testis the size of a hen's egg, with protrusion and loss of a mass the size of a walnut, ending in recovery of the normal condition. These cases are reported as being accompanied by sudden abscess formation with and without fungus testis.

**Symptoms and Diagnosis.**—There are different grades of intensity in orchitis irrespective of cause, so that we may have the mild form, even in a severe injury, and, on the other hand, an apparently trivial cause may give rise to quite a severe attack. To the milder forms belong that after mumps, the so-called metastatic variety. Gonorrhœal orchitis attains a more intense grade, as a rule, according to Kocher; but the most acute and most liable to quick suppuration are those cases dependent upon a nonspecific variety of urethritis, such as that which appears after prostatitis, stricture, and operations upon the urethra. He cites Gardner's cases occurring after lithotomy (see Curling) in support of his assertions, that this variety is most liable to quick suppuration and abscess; also a case of Mr. Hutchinson's. There is no change in the shape of the organ in the acute form of the affection, and not so much increase of size, as a rule, as in epididymitis, the enlargement coming about slowly, owing to the unyielding tunica albuginea; twice or thrice the normal is the rule, though there may be enlargement, even in the acute variety, to the size of a goose-egg (Kocher). The tumor is oval, with a smooth and regular surface, which is more or less intensely stretched, according to the extent of the increase in the size of the organ. The swollen gland gives a feel upon palpation as though there were fluid in it, and this pseudo-fluctuation is apt to be misleading. In the beginning the patient is conscious of a feeling of uneasiness and weight, and extraordinary sensitiveness of the part to the touch; this increasing as the inflammation advances, soon becomes acute pain, located in the testicle itself, and which may radiate in the direction of the loin into the groin and down the thigh of the affected side. There is nearly always a slight elevation of the temperature, but in severe cases it rises quite high, and there may be anorexia, nausea, vomiting, hiccough, constipation, which is due usually to the patient's reluctance to make an effort to evacuate the bowels, insomnia, and nervous irritability. These general symptoms may simulate those of strangulated hernia, especially the more faithfully, when through ectopia the part occupies some region common to hernia (Vidal).

The pain may continue severe for three or four days, even longer; after that time gradually becoming less acute, until nothing is left but a soreness upon touch. If suppuration has taken place, the part immediately concerned becomes softened, fluctuation is felt, and if the abscess is not opened by the surgeon the integument and subjacent tissues become thinned by the pressure and involvement in the inflammatory process, until finally there is a break and the pus discharges itself externally. The abscess cavity usually fills with granulation tissue, and quick healing of the part is the rule.

If the suppurative process has destroyed much of the inter-tubular tissue, prolapses of the seminal tubules may ensue upon the opening of the cavity and discharge of the pus. This condition is caused by the unsupported tubules protruding through the opening of the abscess cavity.

Rarely the cavity does not heal completely, but fills up with exuberant granulations which grow out and around the opening, forming, together with the prolapsed granular structure of the testis, what is known as fungus testis benignus; or a sinus may be left, through which a discharge of thin pus continues for many weeks, or even months, the testicle remaining chronically inflamed, hard, and tender. After the abscess has been opened and the pus discharged, the severity of symptoms lessens, unless there is another focus of suppuration and another abscess forming. This is sometimes the case.

Occasionally suppuration goes on at the center of the gland and does not make its appearance at the surface. When this occurs, the process is a slow one. The organ becomes less tender, gradually reduces in size; the pus inspissates may even calcify; the function of the gland is destroyed; there are chronic pain and a proneness to repeated attacks of acute inflammation. If the process ends in gangrene through complete strangulation, or septic infection of the parts, the scrotal tissues, already adherent, slough, and the dead portion of the testicle protrudes externally as a dry, yellowish mass in the first instance, or as a putrid semisolid, dirty substance in the last. This is a rare termination.

Pain is comparatively more severe in this variety, and the general symptoms in severe cases arise to a height out of all proportion to the amount of inflammation in the organ itself. This is explained by the unyielding character of the fibrous sheath, the tunica albuginea surrounding the glandular structure, which, resisting the expansion of the inflamed tissue, causes the pain. This condition may result in suppuration, or even in gangrene (dry necrosis) (Ricord, Keyes) of a part of a testicle, and is sometimes announced at the time when the patient's suffering is at its height by a sudden cessation of the excruciating pain (Kocher, Keyes).

To differentiate between an inflamed testicle and periorchitis serosa acuta by simple palpation is difficult. Occasionally the latter affection makes itself known through the transparency that may be present, but it is not a constant feature. Much more determinate is the behavior of the epididymis and the skin. The epididymis is demonstrable to the touch as normal unless it shares in the inflammation, and then it is slightly harder, but never so hard as in epididymitis from gonorrhœa. The skin of the scrotum in orchitis differs from that covering over an inflamed epididymis. It is stretched, its veins distended, and it may be red, but not œdematous. This condition, which is contrary to that of the skin in epididymitis and periorchitis, is due to the separation of the gland proper from the skin and subcutaneous tissues, by not only a firm fibrous capsule but by a serous cavity. It is true that the tunica enters here and there into the inflammatory process, but at the utmost in the form of a periorchitis adhesiva, in which an effusion is never present (Kocher). The spermatic cord is, after the first day of the beginning of the orchitis, usually thickened, irritable to the touch, but without any share being taken by the vas deferens.

Kocher states that in intense cases there appeared upon the corresponding side, near the lumbar vertebral column, a spot very sensitive to pressure, with swelling of the retro-peritoneal lymph-glands. The last is not always to be felt, it is true. In epididymitis, also, that has gone on to suppuration, the same is to be found.

The inguinal pain of the corresponding side, with the same distressing, drawing feeling as in epididymitis, may accompany acute orchitis, though it is not so constant, and the painfulness of the testis itself is often the first and most prominent symptom Pains in the small of the back are frequent, and seem to be increased by the dorsal decubitus (Kocher), while the inguinal pain disappears on assuming this position. The pain in the testicle is not in the least relieved by lying on the back and supporting the scrotum, and the character of the pain serves in a measure as a diagnostic point against epididymitis. This pain is a pulling, stretching one, not as in epididymitis as if caused by pressure; and the explanation of it lies in the stretching of the tunica albuginea by the swelling of the inflamed testis. This is proved by the fact that an incision, or several small punctures, through the tunica albuginea, relieves the pain in a few minutes.

**Prognosis.**—Acute orchitis terminates in the majority of cases after a course of from fourteen days to four weeks' duration, according to the severity of the case, in a return of the part to the normal state. In some cases, however, there arise conditions which threaten not only to destroy the functioning capabilities of the organ, but also the patient's life. Atrophy is the most frequent cause of destruction of the glandular structure of the organ, and many cases have been reported as the result of acute orchitis, most of these occurring after mumps (Curling, Kocher, Ziegler, Lesser, English). This atrophy follows immediately upon the swelling, and is likened to the somewhat analogous connective-tissue shrinking of the kidney after nephritis (Kocher).

*Gangrene* as a consequence of orchitis is of rare occurrence. Curling reports a case occurring in his practice, resulting after an attack of acute orchitis, and an abscess which burst spontaneously. He also quotes a case, recorded in Mr. Harvey Ludlow's prize essay, in which gangrene with putrefaction followed acute inflammation of the testicle in a man in feeble health and who had suffered much from stricture. Death, chiefly from peritonitis, occurred. He also mentions another case in an old man from an acute orchitis after lithotrity. Hutchinson (Kocher) reports an analogous case in an old man with prostatic hypertrophy. Kocher claims that after the investigations of Chauveau it may be accepted with certainty that the issue in true gangrene may be referred back to infection through the deposit of septic material from the diseased urethra. Gangrene of the testis with putrid decomposition may occur in a similar manner after injuries and inflammation of the epididymis. Quite different is the condition of destruction brought about after injury of the testicle through the bursting of an abscess. Ricord (Keyes) called this necrosis. This condition has already been referred to under symptoms. Patients debilitated by disease or old age are liable to gangrene of the testis after acute orchitis. Spontaneous gangrene in patients hitherto healthy is rare. Bell has reported cases of such a condition. Through septic infection or suppuration extending along the spermatic cord and setting up a pelvic cellulitis or leading to peritonitis the life of the patient is threatened. An acute orchitis may become chronic. This is usually through abscess formation. In absence of the surgeon's aid the abscess breaks its way with difficulty through the tense tunica albuginea. With children, abscess comes more quickly, with formation of fungus, or followed by quick healing. The abscess may become encapsuled, and remain for many years.

**Pathological Anatomy.**—In four specimens studied by Kocher the following changes were observed macroscopically: The first case was one of acute gonorrhœal orchitis, with unimportant participation of the epididymis, this part exhibiting only a slight thickening. In a second preparation, that of a testis inflamed through violence and undergoing acute suppuration, death resulted. The spermatic cord, which was swollen to the thickness of the thumb, was surrounded by pus. At the height of the under half of the kidney were found pus-infiltrated lymph-glands. In a third preparation of acute orchitis after clap, in which castration was performed three weeks after the beginning of the inflammation, the epididymis showed abscess pockets with raggedly irregular walls throughout its substance. The fourth was taken from a man whose testicle was inflamed by a kick from a horse, and whom it was necessary to castrate. In summing up he says: "The tumor was larger than a goose-egg, and retained exactly the form of a normal testicle. Upon section the tissue sprang into the cut quickly, as if relieved from a strong compression. According to the degree of inflammation in the whole and in places the gland substance appeared hyperæmic, strongly reddened or yellowish in color; especially under the tunica albuginea and along the septa testis were the yellow lines found the soonest." By the formation of circumscribed abscesses they appear lying usually under the tunica albuginea as cavities filled with fluid pus. The albuginea appears somewhat thickened, and the sepa between the lobules of the glandular substance broadened and quite considerably separated. The connective tissue between the tubules is infiltrated with numerous granulated lymphoid cells; its basis substance is granular instead of fibrous as in the normal. In the same there appear here and there vessels filled with blood. The wall of the seminal tubules shares in the infiltration with migratory cells; it is less striped, and its outer contour appears less distinctly normal than usual. The contents of the tubules stand out sharply in their dark shading. The seminal cells are no longer distinctly circumscribed; instead, the lumen appears here and there filled only with a strongly granular mass, which, moreover, contains fat-drops, and at a later stage fat-crystals. In the somewhat more advanced parts the cellular infiltration in the interstitial tissue also appears to have undergone in part granular degeneration. There are also seen here large and small fat-drops and separated cholesterine-crystals; through this the color is intensely yellow. Besides the lymphoid cells one also sees those heaps of larger cells with distinct nuclei found in the normal testicle as collections of larger cells arranged in spindle-form. The same appear often as large, homogeneous masses in the form of a cylinder, in a row one upon the other, as when they are stuck in a vessel. In still older places the cells disappear from the interstitial tissue, and this appears a thickened, fibrous-grown connective tissue with numerous strongly prominent nuclei. The wall of the seminal canals shows the same change. The contents of the latter have in part disappeared—in part still exist; only, however, as a substance consisting of fat-drops and granular matter. In the spermatic cord the vas deferens shows itself unchanged; the infiltration is a phlegmonous one, and belongs chiefly to the connective tissue between the vessels. The same is found in spermatitis after epididymitis. When the epididymis is implicated, there is found the same lymphoid, interstitial cell infiltration as in the testis, with fatty degeneration of the epithelia of the canals; or the migratory cells flow together into abscesses, and press aside the tissue, with partial degeneration of the same. The layers of the tunica are normal, often adherent, in form of an adhesive periorchitis. The foregoing description leaves it to be recapitulated that in acute orchitis it is essentially with an interstitial inflammation we have to deal, just as in epididymitis, with a lymphoid infiltration of the connective-tissue framework, and also of the wall of the testicular canal.

Kocher also calls attention to the rapidity with which the seminal cells undergo destruction through granular infiltration and fatty degeneration. The contents of the testicular canal become resorbed, and the walls contract with the interstitial tissue. The return to normal results through the disappearance of the lymphoid cells by way of the lymphatics, perhaps also through the veins, and in part through fatty degeneration. Only when the removal of the infiltration is rapid is a *restitutio ad integrum* beyond doubt.

**Treatment.**—Rest in the supine position, with the testicle elevated upon the abdomen and supported there, should be insisted upon. A hot poultice of flaxseed-meal applied and changed every two to three hours has, in connection with the hypodermic injection of a half-grain of morphine, followed by a dose internally of an eighth of a grain as often as is necessary to keep the pain down, given me the best results. If the case is seen early, bleeding at some of the scrotal veins, or leeches, ten to fifteen, applied in the neighborhood of the abdominal ring, is still recommended (Bumstead and Taylor, Keyes).

Crushed ice in rubber bags may be applied with a hope of cutting short the process if the case is seen at the very commencement of the inflammation (Curling), but there is nothing to commend this means if the disease has progressed to any extent, and there is always the possibility of its playing a part in the causation of gangrene by its devitalizing power, which will render the employment of it questionable after the inflammatory effusion has taken place. Narcotics in the form of ointments and lotions may be applied, and the efficacy rendered more potent by using them in connection with the hot flaxseed-meal poultice. The bowels should be kept opened, preferably by salines. If, despite this treatment, the pain continues severe, puncture of the tunica albuginea is advised by some. This method of relieving the tension of the inflamed secreting part of the testicle was first employed by Vidal, it being suggested to him by the success of Velpeau, who employed incisions of the tunica vaginalis in cases of epididymitis. Vidal's assertion that he employed it with successful results, and with no case of prolapsus of the testicular substance in four hundred cases, has been severely criticised, and by no one more strongly than by Gosselin, his own countryman, who claims that his cases were not orchitis but epididymitis. However this may be, the principle is a good one, and the method, modified, from one incision one and a half centimetre long, to several punctures through the tunica albuginea, is employed with gratifying results (Keyes, Ashhurst, Wyeth). By relieving the tension the pain ceases in a half-hour or so, and by the continuation of the poultice of hot flaxseed-meal and elevation resolution will usually follow without interruption. Abscess should be opened as soon as fluctuation is detected; antiseptic dressings, and, after the slough has been removed, stimulating applications to hasten granulation and healing in gangrene. If sinuses or fistulæ remain after abscess, and they do not heal through the application of stimulating lotion or injection, they should be slit up, curetted, and packed with iodoform gauze. The general health of the patient should be looked after in these cases of tardy healing. A well-fitting and comfortable suspensory should be fitted on the part by the surgeon as soon as the patient is allowed to be upon his feet.

## EPIDIDYMITIS.

**Etiology.**—By far the most frequently diseased of any part of the testicle is the epididymis. We meet with inflammation of this part as the result of injury, the propagation of disease of the urethral mucous membrane onward along the vas deferens to the epididymis, and by infection through the blood. In short, most of those factors given in the etiology of acute orchitis can also give rise to epididymitis. It begins ordinarily as an acute, painful affection running a comparatively rapid course, to end in a few days in recovery, or it may be subacute from the commencement, accompanied by little pain, dragging slowly over a long interval of time, to heal finally, or lapse into the chronic stage. We have in the gonorrhœal inflammation of the urethra the commonest cause of epididymitis. Even after this causative affection has run its acute course, and has become chronic, epididymitis may arise from it, although there may have been at the time no appreciable exacerbation of the urethral trouble; straining at lifting, excess in drinking, or coitus, are very apt to bring it on, especially if there has been at any time prior an attack. It is to be noted that an inflammation of the epididymis from a chronic urethral affection, be it stricture or long-continued clap, is as often subacute as acute in its behavior, and more apt to involve both testicles. Upon the question as to the frequency with which epididymitis complicates gonorrhœa, there is some difference of opinion between observers, and it is a difficult question to settle definitely. In my private practice it is of relative infrequency, but has happened to 12·2 per cent of my out-clinic gonorrhœal patients. The difference is undoubtedly due to the fact that a larger number of the latter class go without treatment for a longer time, and, besides this, continue their irregular habits, such as drinking and having indiscriminate sexual intercourse. Many of these men have the hardihood to continue at their occupation after epididymitis has attacked them, despite the suffering caused by it. I have seen linemen keep at their work, the latter necessitating climbing and clinging with their legs to telegraph poles, throughout the whole course of the disease, the acute stationary stage of which was thus prolonged in most instances into many weeks' duration. A great many of such cases seek the physician only because of the epididymitis, either having paid no attention whatever to the prime cause (the clap), or treated themselves with some uncertain mixture locally, or internally, or both.

Predisposition in some individuals seems to play a part in the frequency, for there are some who seldom escape it whenever they have a fresh gonorrhœa, or an exacerbation of an old one, no matter what precautions they may have taken against it; while, on the other hand, there are those that may commit the grossest indulgences and expose themselves in every way, and yet never be attacked. Vidal ascribed to atmospheric change an influence in the production of an epididymitis, and thought that a sudden transition from mild to cold weather causes the testicle to take on inflammation more readily while the patient is suffering from gonorrhœa.

In looking over the record of cases from my clinic I find that there are periods when cases present themselves in groups of greater numbers, but that the same thing happens in respect to chancroids, gonorrhœas, and syphilitic outbreaks, irrespective of the weather or time of the year. Epididymitis seldom occurs uncomplicated, especially that due to gonorrhœa, in which there is usually an involvement of the tunica vaginalis, with effusion into the cavity, and frequently an inflamed vas deferens.

It occurs at all ages, but oftenest at that period in life when the organ is at its strongest functioning capability. The reason for this increased frequency is obvious, for it is at this time that individuals are almost constantly exposing themselves to conditions most favorable to the origin of the disease.

Rollet (1862) reported 678 cases of epididymitis in 2,425 cases of clap, $27\frac{9}{10}$ per cent; Jullien (1886) observed it 381 times in 2,500 cases, $15\frac{2}{10}$ per cent; Tarnowsky (1872), out of 5,203 cases of gonorrhœa, saw epididymitis 637 times, about 12 per cent; and Finger, during five years' service in a hospital, saw epididymitis 548 times in 1,844 cases of urethritis, $29\frac{9}{10}$ per cent. As the latter observer says, all these being taken from hospital material, the percentage is much higher than will be found in all the cases of urethritis, for the reason that the greater number of those suffering from simple urethritis do not go to a hospital. Berg (1882), in his statistics taken from his private practice, gives a percentage of $7\frac{5}{10}$.

In the greatest number of cases epididymitis attacks but one testicle, and either with equal frequency (Eichorst, Finger, Lesser). It is not uncommon for the sound testis to become affected after the subsidence of the side first attacked, but this is found to occur more often in chronic affections of the urethra, and in syphilis, when the epididymitis is usually subacute from the beginning. Very seldom in acute gonorrhœa are both sides affected simultaneously. Gonorrhœal epididymitis is dependent upon the direct continuation of the urethral inflammation backward to the prostatic urethra, and thence along the vas deferens to the epididymal canals. The usual time for its beginning is in the fourth week of the blenorrhagia, although it does commence as early as the end of the second or beginning of the third. Finger has given a collection of statistics, gathered from the reports of numerous observers, which gives the earliest time of attack as the first week and the latest as the seventh year. Cases have been reported as beginning earlier, even before the discharge (Sturgis, Berg); but, as Dr. Finger truly says, there is strong probability that there existed a deep-seated urethritis, or a stricture, the result of a former clap. Dr. Keyes believes these cases to have been bastard clap. Out of 1,015 cases occurring at times ranging from the first week to the seventh year, given in this collection, the greatest number, 191, happened in the fourth week. Dr. Keyes generalizes the time by putting it anywhere from the third to the eighth week. The proper treatment of gonorrhœa plays some part in the prophylaxis of epididymitis. Finger gives the following interesting report upon this subject from Lefort:

Epididymitis in cases of gonorrhœa in which there was no treatment, 264; treatment with balsam only, 73; treatment with injection only, 82; treatment with balsam and injection, 60; treatment unknown, 97.

Here of course, as Dr. Finger remarks, the want of treatment is not to be considered as exclusively the cause of the increase in number on the side of epididymitis, for it is this class of careless, neglectful patients that adds to the negative evil of nontreatment, those positive ones of excessive indulgence in drink, in venery, and overstrain at work.

**Symptoms.**—In the acute form of inflammation of the epididymis there is in the beginning a dull, aching sensation, referable to the testicle itself as if it were too heavy, and which may extend up the cord and into the small of the back. Curling states that the epididymitis is usually preceded by uneasiness in the course of the vas deferens, occasionally accompanied by irritation about the neck of the bladder, causing frequency of urination, which is followed shortly by a dull, aching pain, and slight fullness in the groin. Kocher says that pain in the groin is a constant initial symptom, and that it does not belong to gonorrhœal epididymitis alone, for he has repeatedly observed it in the traumatic form.

Keyes also says that it is rarely absent, especially in inflammation of urethral origin, and that it usually precedes by some hours the pain in the testicle. In my practice, both private and hospital patients refer their first sensation to the testicle itself in the majority of cases, and I have not been able to demonstrate the "*doleur susinguinale*" of Fournier as a constant initial symptom.

Finger ranks the inguinal pain as among the more infrequent prodromal symptoms. Instead of the uneasy, heavy feeling in the testicle, sudden acute pain may be experienced as the first sign of anything wrong with the part, but this, in my experience, is not so common a beginning as the one above described. Accompanying the uneasy sensation in the testicle there may be a feeling of general *malaise*, chilliness, loss of appetite, frequent and painful urination, together with pain in the groin and small of the back. The discharge from the urethra usually diminishes very perceptibly several hours before the symptoms of epididymitis appear, and may cease altogether, to return upon the subsidence of the acute symptoms of the epididymitis.

Sometimes the urethra gets well during the epididymal trouble, so that by the time the patient is able to be about on his feet he is cured of his gonorrhœa. However, this is a rare and fortunate termination of the urethral disease. Dr. D. D., a dentist, suffering with gonorrhœa, had his epididymis inflame in the third week of the urethral trouble. The discharge ceased upon the sudden appearance of pain in the testis. The patient was confined in bed seven days before I allowed him to get up. The discharge did not reappear at any time during the attack, although the symptoms rapidly subsided from the time of his going to bed; nor was any sign of the urethral trouble discernible thereafter, even the urine being clear of shreds.

If there is much fever, and a tendency to vomit and collapse in the beginning, before the local symptoms become noticeable, it is usually consequent upon considerable inflammation of the vas deferens (Kocher).

In uncomplicated epididymitis the fever comes only with the objective symptoms as a rule, and lasts but a day or two, attaining to three or four degrees above normal, and subsiding, in most cases, almost always before the relief of pain. Soon after the initial symptoms declare themselves are the objective symptoms demonstrable, and there appears the exquisite sensitiveness to the touch of a part of the epididymis. Upon palpation there is found at some part of the epididymis—the globus major the most frequently, according to the observation of Finger, the globus minor according to Curling, Kocher, Bumstead, Taylor, and others —a small, hard lump, which, increasing as the inflammation advances, soon involves the whole of the epididymis, which may become many times the size of the normal.

The skin of the scrotum upon the side corresponding to the affected epididymis becomes œdematous, hot and red (inflammatory œdema, Eichhorst), and when this œdema is considerable it forms a large part of the tumor. The tunica vaginalis is more or less affected (periorchitis acuta) in acute cases, and there may be considerable effusion into the cavum vaginalis, filling it to its utmost capacity, the increase in bulk smoothing out the folds of the scrotum, thus forming a tense, smooth, oval tumor, in which are masked the constitutent parts of the testicle. The intensely stretched layers of the tunica vaginalis often give rise to excruciating pain, which is not relieved even to a slight degree, by rest on the back, or support of the part, but is subdued immediately upon incising and emptying the sac. Usually there is but a moderate effusion of fluid, and sometimes none at all, the walls of the tunica throwing out a plastic material by which the surfaces are agglutinated (periorchitis adhesiva), the scrotal and testicular tunics thus becoming adherent the one to the other.

The inflammation may extend into and affect the spermatic cord more or less acutely. When this part is affected severely the subjective symptoms are intensified, sometimes taking on the character of strangulated hernia through its pressure, in its swollen condition, against the unyielding external abdominal ring. Sometimes the cord is shortened by the inflammation, and the testicle is pulled up to the outer ring with such force as to increase and intensify the suffering of the patient. The usual form of the swelling in epididymitis is when the inflammation is accompanied by little or no effusion into the cavum vaginalis—that of an irregularly long, angular tumor, flattened from side to side, and, as a rule, about the size of a man's fist. The enlarged, hardened, and exquisitely tender epididymis may be felt at the back of the tumor encompassing the posterior half of the testicle, the fore part and sides of which are felt in front, when the effusion is not enough to prevent the contact, as a soft, pseudo-fluctuating part having the sensitiveness peculiar to it. Sometimes, though rarely, the inflammation goes over to the testis proper. When such is the case we have an increase in the severity of symptoms by the addition of such manifestations as go with acute orchitis. Except by this increase in the suffering of the patient, both general and local, we have, in the event of considerable effusion and the participation of the scrotal tissues in the inflammation, no certain means of determining whether or not the testicle proper is involved.

The above-described changes may develop suddenly. In from two to five days the inflammation may have reached its height. After a stationary period, proportionate in length of time to the intensity with which the different tissues have become involved, the pain ceases and a return to normal begins. After the disappearance of the inflammatory symptoms the swelling may remain for some time. The œdema leaves the scrotum and subscrotal tissues, any effusion of the cavum vaginalis becomes resorbed, the induration of the epididymis gradually softens and disappears, until there is left only a small, hard lump—usually in the tail, sometimes in the head—which upon pressure is still somewhat sensitive, and which usually occupies weeks in becoming resorbed, or which may remain for years, forming a focus from which relapses occur; or it may undergo suppuration, become encysted, undergo cheesy degeneration, and thus form a so-called gonorrhœal tubercle (Birch-Hirschfeld). Very rarely in acute epididymitis do abscesses form that break spontaneously, or that must be opened by the surgeon. If this should happen, or there occurs suppurative periorchitis, the pain in the parts does not subside so soon as that of a simple inflammation, but tends to increase, and there appears a secondary fever with slight chill—in short, the fever of infection. At the site of the most pain, fluctuation after a while is to be felt, and upon incision pus is evacuated, the pain is relieved, the fever subsides, and the part heals. There are such cases as the latter reported (Kocher, Finger, Albert).

The course of epididymitis may, instead of the one above described, be a violent one from the beginning, every symptom simulating those of fulminating peritonitis. The abdomen appears meteoric and distended, extremely sensitive to every movement, to even the pressure of the bed-clothes. The temperature becomes high, ranging from 39·5° C. to 40° C. The pains increase from hour to hour, radiate toward the lumbar region and into the groin. There are eructations, hiccoughing, nausea; finally, vomiting of greenish, bitter masses of mucus, and collapse (Finger). On the contrary, cases may take on a subacute course from the first, the patient suffering very little pain, the inflammation being limited exclusively to the epididymis, even to a part of it. This is usually the course of epididymitis when it is due to a chronic urethral trouble, either an old, deep-seated gonorrhœa, stricture, tuberculosis, or syphilis. Relapses are, as a rule, subacute. Varieties in the form of the tumor are caused by the malposition of the testis and epididymis. Hernia and varicocele can complicate an epididymitis, as the inflammation of the latter may communicate itself to whichever of the two former is present, thus rendering a reducible hernia irreducible, or, by spreading upward along the peritonæum, cause a peritonitis. A varicocele may be made worse by the epididymis growing to it (Finger).

**Diagnosis.**—The pseudo-fluctuation of the testicle should not be mistaken for an effusion into the cavity of the tunica vaginalis (Velpeau, Kocher). The latter is more elastic, more sensitive, accompanied by redness and œdema of the scrotum over the fluctuating place, and is usually, though not always, translucent. Furthermore, an effusion into the cavity prevents the outlines of the edges of the infiltrated epididymis being felt so distinctly. The characteristic form of an infiltrated epididymis serves to distinguish it from acute orchitis. There is very seldom an exudative periorchitis present in acute orchitis (Kocher).

**Prognosis.**—Healing of the parts takes place, but in the majority of cases a perfect restitution to the normal does not occur. There have been instances reported of the disease terminating fatally, but in every instance peritonitis or purulent infection has been the direct cause (Velpeau, Kocher, Keyes, Finger). The indurated lump left after subsidence of the general infiltration in the epididymis may be the exciting cause of tuberculous deposit, especially when the epididymitis is of gonorrhœal origin (Bumstead and Taylor). Cases have been reported of acute miliary tuberculosis of the testicle following upon gonorrhœal epididymitis in patients of robust health (Albert). As regards the functioning capability of the organ, the prognosis is bad, especially after gonorrhœal epididymitis. Through inflammation of the walls of seminal canals and the interstitial connective tissue, the former are cemented together and their lumen occluded, thus destroying their power of conducting the semen from the testis proper. Liégeois (Kocher) found after unilateral epididymitis important lessening of the spermatozoa; in twenty-eight cases of double-sided epididymitis, he found complete absence of the spermatozoa in twenty-one. Of the seven cases in which he found the spermatozoa, five were not gonorrhœa, and two were quite light cases in which there was no induration left behind. In eighty-three cases of double-sided gonorrhœal epididymitis, in eight only did the power to excrete spermatozoa return (Kocher). Curling reports cases of obstruction to the seminal canals, in one of which, however, the function returned after two years' treatment. It is fortunate for the integrity of a patient's procreative power that the two testicles are not affected oftener, for it is shown on section that, though the hard lump may disappear and leave the epididymis to the palpating finger apparently normal, yet microscopically the lumen of the canal is found to be destroyed. Even though the patient has suffered from double epididymitis, this does not render him impotent. His sexual power and desire are normal; he still ejaculates a fluid in all respects similar to that secreted before the inflammation, except that it contains no spermatozoa (Gosselin). He is sterile, but not impotent. In many cases this sterility is removed by absorption of the infiltration left after the inflammation, but it is after a long time. When it is due to destruction of the lumen of the canal of the epididymis, of course the defect is permanent.

**Pathological Anatomy.**—In a similar manner to that of acute orchitis the epididymis becomes infiltrated, only that here there is more room for an interstitial cell infiltration. In gonorrhœal epididymitis the epithelium of the canals may become crowded with round cells, even to the filling of the lumen. At the same time there may be found a mucoid degeneration and a desquamation of the epithelia instead, so that a perfect picture of catarrhal inflammation is present.

**Treatment.**—For the acute cases, rest on the back, with the testicles drawn up on to the groin of the affected side, application of hot flaxseed-meal poultices, changed every two to three hours according to the amount of suffering, will give relief from the pain in a few hours, in the majority of cases, and hasten the termination of the disease. Narcotics in the form of lotions or ointments, as suggested in the article on acute orchitis, are valuable adjuncts. Keyes recommends a tobacco poultice from the start, and I have found it of considerable value as a narcotic in cases where the patients are not addicted to the free use of tobacco. When this is the case, and the patient is accustomed to the effect of tobacco, it will be of little use to him in this instance. An opiate in the form of an ointment or a lotion should be used instead, in connection with the poultice—a half-grain dose of morphia hypodermically, followed by doses internally of one eighth of a grain every four to six hours, to keep the pain down in extreme cases, especially if orchitis complicates the epididymitis.

When there is much sudden effusion into the cavity of the tunica vaginalis, an incision into and emptying of the same will relieve the pain immediately when due to the stretching of the tunica (Velpeau). Sometimes, though rarely, an abscess forms rapidly (Kocher) and is the cause of the pain; it should be opened as soon as fluctuation is felt. In four to five days most cases will have run their acute course, and the inflammatory symptoms having disappeared, nothing is left but the swelling, due in part to the œdema and effusion, in part to the cell infiltration of the epididymis. Instead of acute pain, there is only soreness upon touch, as long as the patient is in the reclining position; a few minutes in the erect posture, however, serves to bring it back in a measure; and but a few hours upon the feet, without the testicles being supported, will cause a return of all the inflammatory symptoms. If, now, there is applied a proper support, either through strapping, as minutely described by Dr. Keyes, or by means of the Horand-Langlebert suspensory, which has in my practice superseded all other methods of support by reason of the admirable results obtained since I began its use, the patient will be enabled to go about his work without pain, and with but little danger of the return of the inflammation. Those patients that refuse to go to bed at the beginning of the attack can be made comfortable by means of this appliance, and are thus permitted to go on with their business in comparative comfort in all those cases where the cord or the testis proper is not involved. When there is much effusion into the cavity of the tunica vaginalis, tapping should be resorted to before the bandage is applied. Since I began the use of this suspensory in my clinical practice, very few of those patients go to bed throughout any part of the disease. I have had them come to me suffering all the agonies of acute epididymitis, unable to stand erect, and almost creeping into the clinic-rooms, supporting themselves by a cane, going away in ten minutes erect and free from all suffering, relieved by the application of this suspensory bandage. Finger recommends it highly in his book (the edition of 1888), and also in his last book published in 1891. Dr. George Brewer, of New York city, has reported similar results with the original Langlebert, which is not so simple of application. The constituent parts of the bandage are a thick layer of cotton-wool, with which both testicles are enveloped, a piece of gutta-percha tissue or oiled silk on the outside of this, and a suspensory bandage of linen placed over the whole. When this is properly applied the testicle is lifted up against the front of the pubis, thus relieving the cord of its weight, and it is held there with a firm and soft compressure. Every day this should be repacked, as the cotton soon gets matted and hard, thus lessening the necessary even pressure. It should be worn day and night.

When the inflammation has been allayed, or rather has run its course, and all danger of return is past, we should endeavor to hasten resorption of the indurations left behind. The application of stimulating ointments or lotions, or of three or four folds of linen wet in warm water and placed next to the skin over the callosity, with the bandage adjusted as above described, is highly useful (Finger). I have used of late, with much satisfaction as to results, a thin layer of absorbent cotton saturated with glycerin, to which, if a stronger counterirritant is desired, there may be added, to the strength of one drachm to the ounce, the tincture of iodine, applied to the scrotum over the affected testicle; on the outside of this, and covering the healthy testicle as well, a piece of oiled silk or gutta-percha tissue is applied, then a thicker layer of cotton, and over this the bandage is applied. This need not be changed oftener than once in twenty-four hours. The internal and external use of iodine locally in the form of a tincture alone, or of Churchill's solution, while the potassium iodide is given internally, is said by some to assist absorption. My experience with it in nonsyphilitic induration has not led me to regard it as much of an aid. When the epididymitis is due to urethral trouble of a chronic nature, either stricture or deep-seated gonorrhœa treatment of these parts with a view to curing them should be begun; and in my experience the instillation into the deep urethra of the nitrate of silver, first recommended in the treatment of this disease by Prof. W. Boeck (Bumstead and Taylor), gives the best results, though I do not limit the medicament to a minute quantity, injecting instead all the way from one drop to a drachm, commencing with one grain to the ounce and going as high as forty. In the event of a small-calibered stricture of the urethra, dilatation must be accomplished up to the size required for the introduction of the injection. This dilatation may be kept up at proper intervals without regard to the presence of the epididymitis, which is in most cases from this cause subacute. Any local treatment of the urethra during an epididymitis arising from an acute gonorrhœa of only two or three weeks' duration is liable to make matters worse, and in my opinion should not be attempted. It has been my custom during the last four or five years to stop the balsams at the appearance of the epididymal inflammation. I can only say in regard to this custom that in a few instances—not many, it is true—I have seen relapses upon the resumption of balsam copaiba without there being at the time any other cause obvious. In one of my cases it happened three times in succession.

## CHRONIC ORCHITIS.

**Etiology.**—The acute form of orchitis may become chronic by the formation of abscesses or through induration. Rupture of abscesses during the acute stage, with a formation of sinuses and fistulæ, often result in a chronically inflamed testicle, with a tendency from time to time to exacerbations and to increased connective-tissue formation ; or the acute form may go over to induration through the continual growth of interstitial connective tissue from the albuginea and septa. Kocher describes an orchitis, chronic from the beginning, which is most insidious, and of which there are two forms, the diffuse and the circumscribed. Rindfleisch calls the former orchitis atheromatosa. In chronic diffuse orchitis the principal change is in the collection of round cells in the interstitial tissues, the chronic course of the process showing constantly an increase in the connective tissue surrounding each collection. In this form of the disease the organ may become quite large, even as large as the head of a newborn child. The tumor is evenly oval, with the epididymis in recent cases drawn out along the posterior border, to become later a part of the tumor without definition. By the increased growth of the connective tissue about these cell collections, and the degeneration of the latter, a cyst is formed. Each cyst may become very large. In the circumscribed form there is the presence of abscess. There may be one or more of these abscesses, and the size varies from a pea to a walnut. These abscess points may be situated peripherally, or confined to the center of a testicle. The epididymis is rarely if ever a sharer in this condition, remaining perfectly normal, or at most simply indurated. In some cases of chronic orchitis there may be considerable hydrocele present, which, according to Kocher, is in most cases dependent upon the primary orchitis, although he saw in one case an orchitis developed first, after treatment of a hydrocele by the repeated injection of a small quantity of alcohol. In four cases out of thirteen reported by him, chronic orchitis was consequent upon repeated attacks of gonorrhœa, or in consequence of severe strain or wounds after an early gonorrhœa had existed, or after chronic nonspecific urethritis. It may arise from stricture of the urethra.

**Symptoms and Diagnosis.**—The insidious manner in which the disease begins in many cases, and the long duration, characterize chronic orchitis. Diffuse orchitis, as well as the circumscribed form, according to Kocher, develops in just this manner. In both the testicle becomes much enlarged—larger in the diffuse than in the circumscribed form. When there is no interruption through exacerbations the course may be a painless one, the patient complaining only of the discomfort caused by the increased weight of the organ. From this perfectly chronic course there are the most different gradations up to an acute orchitis. Not seldom to be observed is the interruption of the chronic course through subacute attacks, while, amid passing pains, a spontaneous rupture of an abscess occurs and a fistula forms, which exists, as a rule, for a long time; and rarely there is formed a fungous testis (Curling). The indurated connective tissue surrounding the abscess is not favorable to the production of healthy granulation tissue.

The rupture of abscesses, with subsequent formation of fistulæ, can repeat itself many times within the course of a month or a year. In this case the tumor may become contracted into a hard, fibrous, usually irregular body. A third category of cases consists of those in which there is pain from the beginning, which, through slight strain, blow, or upon pressure of the testicle, is increased. The pain is usually local, though sometimes referred to the lumbar region, and the testicle is strongly sensitive to pressure. The abscess in this variety is long in rupturing, as the tough capsule prevents the breaking through of the pus. Finally, there are cases described that, between the acute and the chronic forms, hold a middle position. Kocher contends that these should be classed as belonging to the tuberculous testis.

**Diagnosis.**—The differential diagnosis must establish itself between a chronic plastic periorchitis, tuberculosis of the testicle, syphilis, and slow-growing neoplasms. The confounding of the diffuse form with chronic plastic periorchitis is especially easy. There is in both cases a more or less oval tumor, of elastic consistency and uniform surface, often somewhat flattened from side to side. The growth may be in both a perfectly unbroken and very slow one, drawing itself over many years; or there appear from time to time passing pains and slight swelling. Finally, in both a rupture may occur and a fistula form, in which there may be felt in both, upon the passing of a probe, a thick, tough wall, and even here and there places where there is a calcareous deposit. The following are distinguishing points in the differential diagnosis:

In orchitis, in the earlier part of its course, the epididymis is easily palpated in its entire extent. It occupies a posterior region of the tumor. In periorchitis it disappears very soon, hidden by the folds of the tunica vaginalis. In periorchitis one may distinguish in the wall hard and soft spots, corresponding to increased thickening and chalky deposit—ften, also, hard strips running diagonally over the front layer; and frequently there is at the posterior region of the tumor a place of softer consistence, with somewhat greater sensitiveness on strong pressure. In orchitis the consistence is usually uniform, and if certain places appear more solid, and others fluctuating, by the formation of points of suppuration, still the first are not so singularly hard as the circumscribed irregular plates and knots in the wall; an especially sensitive point of softer consistency is not present at the posterior part. Not too much should be expected from puncture; only by the emptying of the changed blood elements are there positive signs of periorchitis. Besides periorchitis, the diseases the most in accord with the slow and unbroken course of chronic orchitis are syphilis of the testicle and certain benign tumors of the organ, such as genuine cystoma testis. In the formation of isolated abscesses, together with aggravations from time to time, with or without rupture and fistulæ, lies the danger of confounding chronic orchitis with tuberculosis of the testicle. The chief distinguishing point here is the constancy with which the epididymis is first attacked. The testicle proper is attacked before the epididymis, as a rule only when the epididymis of the opposite side has been affected, or there is tuberculosis of some other organ.

**Prognosis.**—The prognosis of chronic orchitis is better than that of the acute form, inasmuch as there exists no danger to life. As regards the preservation of the organ it is worse. Recovery from the inflammation, with preservation of the functional capability, must be regarded as an exception. One issue is that in which, without rupture, a degeneration and resorption of the inflammatory product takes place, the testicle again becoming small, soft, insensitive upon pressure, and a fibrous degeneration with destruction of the seminal canaliculæ ensues. Another issue is that of opening with emptying of the inflammatory product, either artificially or spontaneously, and cicatricial contraction of the organ (Curling). Usually the abscess remains open for a long time, the fistula not closing for years. Still, there may be healing, with partial preservation of the organ. Fungous testis is rare in chronic orchitis.

**Treatment.**—Internal treatment has little or no effect upon chronic orchitis. The patient's general condition should be regarded, and tonics given if there is debility. Treatment of the urethra, if the cause lies therein, should be begun at once. The employment of lotions and salves to the part is a useless waste of time. The testicle should be supported by a well-padded suspensory bandage. If by the means above mentioned the patient is not benefited, castration is indicated in the diffuse form. Every effort should be made to save the organ in the chronic circumscribed form. Kocher advises incision and removal of the products of inflammation. However, if after incision the fistulæ do not heal—and this, as a rule, is the case—and the organ is thickened and irregular from connective-tissue growth, the question of castration comes up; and as the organ has become a useless one, there is no reason why the patient should not be given the benefit of the operation, as, after the removal, quick healing of the wound follows, and the patient is freed from a disagreeable condition. When the abscess is of limited extent, Kocher recommends a proceeding by which the chronic condition is changed into an acute one, with redness, increased swelling and sensitiveness, and which when incised is usually followed by rapid healing. This proceeding, as carried out by him, is the injection of tincture of iodine by means of a Pravatz syringe into the abscess, repeated until the acute symptoms appear. He employs this method sometimes in acute orchitis with abscess.

## CHRONIC EPIDIDYMITIS.

According to Kocher, the pathological anatomy of chronic epididymitis is still less supported through indubitable investigation than that of acute epididymitis. In a specimen in my possession, taken from a patient who had suffered for two years from the inconvenience of its bulk more than from any pain, the history is that of a chronic inflammation from the very beginning. Six weeks after a gonorrhœal infection for the first time his right testicle began swelling, became slightly painful and very hard. He was never laid up with it, nor was it painful for any length of time. After a while he noticed that the swelling was increasing, and after a year consulted a surgeon, who tapped him, drawing off considerable fluid, which reduced the swelling about one half, leaving the tumor still very large. About six weeks after the last tapping the patient presented himself at my office with a tumor as large as a baby's head. After removing the fluid, which amounted to eighteen ounces, I found that nearly half the original bulk still remained, and upon palpation thought that I could detect fluid. The tumor was very elastic, and my impression was that it was the testis proper that was involved, with perhaps cystic degeneration. I advised extirpation, to which the patient consented. Upon section, the tumor was found to be comprised of the epididymis, which completely surrounded the glandular structure, the greatest bulk occupying the anterior aspect. The intertubular tissue of the epididymis had undergone fibrous degeneration, and the epididymal canals had expanded into cyst cavities, ranging from the size of a small pea to that of a walnut, containing a perfectly colorless fluid. The testicular structure had undergone apparently no change as to size, but there was a beginning granular degeneration, together with a fatty transformation in streaks.

In chronic epididymitis the increase in size and induration of the organ is quite constant, brought about, according to Kocher, by the growth and increase of the connective tissue between the coils of the epididymal canals. This author describes this newly formed tissue as having the character of a formed connective tissue with distinct striping, a formation of lines in bundles, with cells and nuclei appearing quite in the background. It has the appearance of a callous scar. Great weight should be laid upon this, as especially contrary to syphilitic induration. Still quoting Kocher, there is to be found in certain cases, besides this whitish, callous, true connective tissue, nothing but the remains of the epididymal canals; the walls of the same are melted into the surroundings, the fatty degenerated epithelia presenting as yellowish granular collections of oblong form. In other cases the callous collections appear of yellow color. The connective tissue is infiltrated, with round cells which undergo granular and fatty degeneration. In the last case, finally, there is found in the callous tissues softening deposits with the usual contents of a chronic abscess. The walls are covered by a so-called pyogenic membrane, or there are fungous granulations upon the inner layer. There is a limitation to the inflammatory deposit, which is characteristic of chronic epididymitis, through newly formed connective tissue, of the character of scar tissue, in which there forms around each individual deposit a sort of capsule, that gradually goes over into the surrounding tissue, or in which the lines of firm connective tissue are interspersed among multiple collections.

Herein lies a difference between tuberculosis and syphilis; also where the same leads to points of suppuration.

Kocher has failed to demonstrate satisfactorily, to himself at least, the pseudo-tuberculosis described by Fournier, coming only after chronic gonorrhœa and presenting a picture almost identical with that of tuberculosis. Dr. Albert, in the last edition of his book on Surgery, 1891, makes no mention of pseudo-tuberculosis, but calls attention to the frequency with which gonorrhœal inflammation of the epididymis is followed by miliary tuberculosis of the organ.

**Symptoms.**—As a rule, chronic epididymitis follows upon an acute inflammation of this part of the testicle, oftenest after gonorrhœal epididymitis. Instead of the remains of a former acute process—those hard deposits in the tail or head of the epididymis becoming insensitive upon pressure—they remain tender after weeks and months, and upon extra exertion, such as that of lifting, bowling, riding, or long walks, become painful, and inflammation follows. The pain is not always confined to the testicle, but may be experienced in the groin or even in the lumbar region. Objectively, one finds a knotty, hard thickening in the globus minor or globus major, sometimes in the body itself, at some part or other. The whole of the body of the epididymis may be enlarged, but usually, contrary to the condition in the acute form, it is only a part. These knots are roundish, not so angular and irregular as are those in tuberculosis, and they lie in the otherwise healthy epididymis (Kocher). If the whole epididymis is affected, there arises a tumor analogous to that in the acute form. By this it is distinguished from the irregular form of the tuberculous variety. The nodules in the epididymis are painful upon pressure, often extremely so. The tunica vaginalis is usually a sharer in the inflammation, either in the form of an adhesive periorchitis with a gluing together of the two surfaces, or—and this is most commonly the case—there is a serous effusion into the cavity (periorchitis serosa). The etiology lies mostly in the exciting cause which operates upon an epididymis already changed by former acute inflammation. Still we may have an epididymitis, chronic from the beginning, arising from chronic gonorrhœal urethritis; also, according to Kocher, from urethritis of nonspecific origin and from stricture. Cases arise for which no cause can be recognized. The course of a chronic epididymitis is a long and tedious one, especially when there is abscess. Owing to the encapsuling of the suppurating point, breaking through of the abscess is hindered, but after weeks, or months it may be, there is a rupture, and a fistula forms which will exist for years.

**Treatment.**—Support of the parts by means of a well-padded suspensory, and the removal of the exciting cause, if possible, and abstention from coitus, tend to alleviate the suffering and to promote a cure, if the process has not gone too far. Local treatment in the form of salves or lotions does little good in this form of the disease, and the internal administration of drugs still less. If by the above means the condition is not remedied, castration is advisable. Kocher recommends incision and removal of the indurated mass, together with all abscess points present. The incision should be made behind. As he says, this proceeding is especially indicated in partial epididymitis—that is, the presence of isolated abscesses. When the whole of the epididymis is involved, either by the induration or through multiple abscesses, castration is the only remedy.

## SYPHILITIC TESTICLE.

Syphilis of the testicle is divided into two forms: syphilitic epididymitis and syphilitic orchitis, diffuse and gummy.

**Syphilitic Epididymitis.**—When syphilis attacks the testicle, in the early part of its secondary period, it is usually the epididymis that is affected. Although the fact that the epididymis is alone attacked at times by syphilis was recognized by some of the earlier writers, Dron, 1863 (Gosseling), was the first to write an elaborate report of it, in which he attempts to classify it as a variety of syphilitic inflammation distinct from that attacking the testis proper at a later period. This distinction, it seems, was based upon its precocity, syphilis of the testicle being regarded at that time as one of the later manifestations of the secondary period, or of the earlier part of the tertiary period. It has been demonstrated, however, by clinical experience, that the epididymis may be the seat of syphilis in the tertiary stage, and that, on the other hand, the testis itself becomes affected early in the secondary period (Ricord, Reclus, Gosselin). Dron designated as the time of appearance of syphilitic epididymitis that of the third and a half month after the appearance of the chancre. Fournier, who studied this affection afterward, as also did Balme, placed the time at the seventh month from the date of the chancre; and Balme reported it as occurring even as early as the second month, and as late as the eighth year. I have seen it as late as the twelfth year of the disease. The part of the epididymis most commonly the seat of the attack is the globus major, though the infiltration may spread thence throughout the body into the globus minor, the whole of the epididymis being involved in the process. This does not occur often, the globus major being usually alone affected throughout the course of the attack, especially if treatment is begun soon after the deposit takes place. The globus minor may be simultaneously attacked (Dron, Fournier, Bumstead, and Taylor), as also the cord (Bumstead and Taylor). The deposit is usually in the form of a round or oval tumor, of smooth surface and firm consistency, the size varying in accordance with the amount of epididymal structure involved. The nature of the process is, it seems to me, the same as that characterizing sarcocele of the testis, and consists apparently of an intertubular deposit of plastic material, showing little tendency to change, either generative or degenerative. The epididymal canals are not obstructed by the deposit, as Dron demonstrated in a case in which both testicles were affected simultaneously. He found spermatozoa in the semen of his patient. There is very little pain connected with an attack, the patient oftentimes being made aware that something is wrong with the part through accidental discovery of a lump there. It may affect both epididymes at the same time. Complete recovery ensues under antisyphilitic treatment.

**Syphilitic Orchitis or Sarcocele.**—There are phases in the behavior of syphilitic orchitis that necessitate a division into two forms—a diffuse and a circumscribed gummy form.

In the *diffuse form* there is an infiltration of the stroma of the testicle with small cells or nuclei, which after some time develop into connective tissue, the latter at a still later period undergoing a strong fibrous contraction under the pressure of which the testicular parenchyma is destroyed (Ziegler). These cells appear to spring from the inner layer of the tunica albuginea and connective-tissue framework, the intertubular septa of the gland. The process is an indolent one, accompanied by very little pain either spontaneous or upon pressure. The testicle increases in bulk slowly until sometimes the size of a very large fist is attained, retaining throughout the enlargement, however, its normal shape and smooth contour. The whole, or a part only, of the testis may be involved in the process of fibrous contraction. There is no tendency to suppuration exhibited by this form. The epididymis is often involved, though mostly at a later period. This form is also known under the names of syphilitic sarcocele and syphilitic albuginitis. The time when this affection attacks the testicle usually is that in the interval between the second and fourth years, during which time it attains its maximum frequency (Gosselin). Cases have been reported as occurring as early as the third and a half month (Nélaton, Ricord, Réclus, Gosselin), while cases occurring in children affected with congenital syphilis have been reported in which the sarcocele existed at birth (Cornil). It may appear very late. Jonathan Hutchinson reports a case as occurring in a patient twenty years after a chancre; and I have at the present writing a patient in whose testicle both forms are present, and it is now seventeen years since a chancre appeared, followed by a secondary eruption.

The second form, the *circumscribed gummy orchitis*, is characterized by the deposition in places throughout the testicle of nodules, multiple usually, varying in size from that of a point barely discernible by the naked eye to that of a hen's egg, of a yellowish color and firm consistency, and which after a time usually undergo softening. These nodules consist of a collection of nuclei, fat-drops, and granular matter, through which is interspersed a stroma of fibrous tissue. Kocher holds that it is impossible to distinguish more than a quantitative difference between the diffuse and the circumscribed gummy form. In the gumma, he says, there is an extraordinarily stronger increase of nuclei; through this is caused not only the destruction of the seminal tubules at the places attacked, but of the vessels also, and there appears a granular degeneration of the formed elements. To this difference he ascribes the difference in the course of the two forms, the diffuse organizing itself into firm connective tissue, the circumscribed going over into granular degeneration. In the great majority of cases there are found side by side both forms and the view that the gummata are mostly situated in the callous tissue is, according to Kocher, perfectly right, and it affords above all things a most characteristic picture. While the diffuse growth develops itself into fibrous tissue, there goes on, at those places of more intense collection of cells, destruction of the vessels, and thus is brought about granular degeneration. These gummy nodules may be superficial or deep, and they may soften and rupture externally, though, as in the diffuse forms, they may become stationary, finally undergoing contraction (Finger). When these nodules are superficial the smooth contour of the testicle is broken by them, becoming knotty and irregular according to the number and size of the nodules; by the pressure of one or more upon the investments of the testicle, these latter are softened and agglutinated one by one, the skin becomes livid and thin, and rupture with emptying of detritus, flocculent pus, and gummy fluid follows.

The tunica albuginea, and also the tunica vaginalis propria, are involved in the process of infiltration, undergoing thickening, and later on cicatricial contraction. There is nearly always a serous effusion into the cavity of the tunica vaginalis, and quite a large hydrocele may exist. This hydrocele may be masked by a very much thickened and intensely stretched tunica vaginalis communis, it being difficult through this to distinguish any fluctuation.

**Symptoms and Diagnosis.**—Syphilitic testicle can be confounded with gonorrhœal epididymitis only when it is the epididymis that is affected in the former, and when the latter is chronic. The distinguishing points are the slow and almost painless course of syphilitic epididymitis, the involvement of the globus major usually, whereas in gonorrhœa the globus minor is the seat of the affection, and a history of a sore at some time which was followed by an eruption. In chronic gonorrhœal epididymitis we have more pain, with a history of discharge and an acute beginning. Syphilitic testis has often been mistaken for tuberculous testis, and patients have suffered needless castration in consequence of the mistake. Tuberculosis, when it attacks the testicle primarily, chooses, as a rule, the globus minor of the epididymis as the seat of its action. This fact serves in a measure to distinguish it from the epididymitis of syphilis.

Syphilitis and tuberculous orchitis are distinguished one from the other more particularly by the clinical behavior of the two respectively. The former runs a course comparatively simple in that from the beginning to the end its manifestations are accompanied by very little pain. One peculiarity in this disease is the almost entire absence of pain upon pressure ; even in those cases where there is spontaneous pain, and in those where abscess with rupture and fistula formation have occurred, still there is no pain of any consequence upon pressure. Abscess formation with rupture takes place more slowly. The vas deferens and prostate are free from the disease. Tuberculosis testis, on the contrary, has a more rapid course, leads more frequently to suppuration and caseous degeneration, and is accompanied by more pain. While there is very little spontaneous pain compared with the objective symptoms—that is, the sudden swelling and rapid formation of abscess—the organ is usually more than normally sensitive to pressure. The vas deferens, prostate, and seminal vesicles, are usually more or less affected. There remains to be mentioned the greatest of all the distinguishing points, and that is, the result of treatment. Under proper treatment syphilitic testicle gets well, while treatment internal or otherwise has little or no influence on the course of tuberculosis of the testicle. Malignant new formations, such as sarcoma and carcinoma, grow much more rapidly and irregularly, are painful, localize themselves preferably only in the testis proper, carcinoma leading without softening to rupture and rapid decay.

**Prognosis.**—The prognosis is good. Even after the affection has existed for some time, enough of the parenchyma usually escapes to preserve the function of the testicle. Gosselin found the spermatozoa in the semen of patients after they had been cured of double syphilitic orchitis.

There is a tendency to relapse if the treatment is not kept up a sufficient length of time.

**Treatment.**—By the proper administration of potassium iodide and mercury the worst cases as a rule get well. No matter how little of the testicle is apparently left, and even though it is the seat of numerous softening gummata, with or without rupture, or the seat of a fungus, a comparatively good testicle can be saved. There is never a rational excuse for the use of a knife when there is a question of syphilis, at least until proper antisyphilitic treatment has been persisted in for some time and has failed. Locally, a suspensory bandage for support—and, when there are ulcers, some simple antiseptic and protective dressing—is all that is required.

### FUNGUS TESTIS BENIGNUS.

In 1808 Sir William Lawrence (Curling) wrote an article describing for the first time the true nature of this condition, and after him came Malgaigne (Kocher), and later still, in 1840, Jarjavay (Gosselin), the latter separating the disease into two forms—a superficial and a deep. As the superficial form is not in any way connected with the testicular parenchyma—being, in fact, as Kocher has aptly termed it, a prolapsus testis—it is not considered a true fungus testis, therefore will have no place in this article.

The commonest form of fungus testis benignus is that of a reddish or yellowish swelling, which, covered over by a layer of granulation, grows out from the parenchyma of the testis through an opening in the scrotal tissue, to reach a size varying from that of a hazelnut to a walnut, or even to that of a large-sized hen's egg. The skin of the scrotum itself is contracted, thickened, strongly corrugated, and separated usually from the granulating and glistening tumor by a deep furrow, in which runs an undermined edge of atrophied skin about half a centimetre broad (Kocher), or the ring of skin may be hypertrophied and everted (Curling). In the scrotum are to be found the elements of the spermatic cord at the back of the tumor, and a small, firm mass at the lower end, which corresponds to the epididymis.

It will not be often that both testicles will be seen to be the seat of fungus testis simultaneously. Sir William Lawrence reports two such cases (Gosselin and Walther). Instead of protruding in a mass of considerable size, as above described, the tumor may through decay be reduced in size, barely extending beyond the opening in the scrotal covering, its regular smooth outline destroyed by furrows and deep fissures; or the mass, instead of presenting a reddish or yellowish appearance, may, through bleeding into the granulations, become black and marbled; in other cases, through other changes, whitish and lardaceous (Kocher); and Lawrence (Gosselin and Walther) reports a case which was perfectly smooth, and even with no trace of granulation. Syphilis is considered by the majority of authors to be the greatest etiological factor in the production of fungus testis.

Kocher gives, as next in order of importance, tuberculosis of the testis, though Ziegler ranks it before syphilis in this respect. Gosselin doubts the formation of fungus from this cause, and Deville (Gosselin), who has shown that the fungus of tuberculosis is superficial—a hernia testis (prolapsus testis of Mocher), in fact—denies absolutely that the deep fungus testis arises from it. Réclus is inclined to rank it as a cause, though he thinks that there has never as yet been a single case described. Kocher refers to a case observed by Herff as one of deep fungus tuberculosis. I have seen two cases of prolapsus of the seminal tubules in tuberculosis testis, but nothing of the nature of a fungus. Simple inflammation of the testis, acute and chronic, acts as an occasional cause through abscess formation with rupture (Curling, Kocher). The formation of the tumor occurs in this wise: Whenever, at the time of inflammation of the parenchyma of the testis, there is formed an opening through the tunica albuginea, tunica vaginalis, and scrotal tissues, either by a considerable incision through abscess and rupture, or through the softening and breaking down of some diseased process, such as in gummata of syphilis, we have an extrusion of the testicular structure, together with such infiltrate as may have taken place, provided the presence of the latter is sufficient to cause an increase of the intercapsular pressure. By this pressure the contents of the capsule are forced through the opening to the outside, where its surface, covered with a layer of exuberant granulations, grows laterally as well as anteriorly through new tissue formation. The scrotal tissues, tunica vaginalis, and albuginea are retracted. The bulk of the tumor is formed of the tubules, intertubular tissue, and new growth; sometimes the whole of the testicle being upon the outside, the stem and base comprised of the epididymis still within the scrotal walls, it increases in size through new tissue formation, and thus is formed a fungus testis benignus. Sometimes, after the rupture of an abscess formed in acute chronic or simple orchitis, the cavity thus left is filled with exuberant granulations that, continuing in growth, protrude from the opening and form a fungous tumor consisting entirely of granulation. This is not a true fungus testis.

**Diagnosis.**—The diagnosis of fungus testis benignus is not difficult. Especially characteristic is the circumstance, that on the inner part of the scrotum there is to be found, connected with the tumor, the normal or characteristically indurated epididymis as well as the spermatic cord, and the absence of any other swelling. The fungus is covered with healthy, hæmorrhagic, cheesy, or lardaceous granulations, accordingly as it belongs to an orchitis, tuberculosis, or syphilis. If it consists of simple granulations it is soft, solid, and firm, or cleft in syphilis, firm or interspersed with furrows, fistulæ, and cavities in tuberculosis (Kocher).

**Treatment.**—When the fungus is due to syphilis it will heal promptly under the proper treatment of the causative disease, it being rarely, if ever, necessary to interfere locally—an antiseptic application when there is sloughing, or a protective dressing, being about all that is indicated. If the tumor is the result of tuberculosis, and there is involvement to considerable extent, no improvement ensuing from building up the patient's general health by tonic, castration is indicated. Removal of the growth by excision, scraping, and cauterizing the cavity which is left, may be employed as a means of healing the trouble, but there is usually a suppurating sinus left which does not heal. Good results may be expected from this procedure only when the fungus is quite small. In fungus which has arisen upon the bursting of an abscess in simple orchitis, application of a cloth wet in silver-nitrate solution and compression, as recommended by Curling, are of undoubted worth. If by these means the fungus is not healed, destruction of the tumor by means of a curette, followed by the cautery, is the plan that Kocher advocates. The operation devised by Syme (Curling), in 1845, which consists in freeing the skin at the base of the fungus, freshening the edges, and, after making an incision at each side of the flaps, thus allowing them to be moved, uniting them over the tumor, may be employed with success in cases due to simple orchitis.

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# DISEASES OF THE TESTICLE.

By JOHN P. BRYSON, M. D.

## CYSTOMA TESTIS.

The testis is sometimes, though rarely, the seat of a growth composed of tough-walled cysts joined together in a compound mass by their walls as they come in apposition, and by an intermediate, apparently fibrous, tissue. The characteristic formations are the cysts, but these may be associated in various degrees, in different cases, with other elements such as sarcomatous, carcinomatous, and cartilaginous tissues. The cysts vary in size from that of a millet seed to that of a pigeon's egg, and are oval in shape. They are sometimes simple, but often contain intracystic cellular growths covered by cylindrical epithelium with or without cilia. The cystic contents vary, being in some cases clear, in others bloody and glairy, while in others still the contents may be cheesy. The whole mass is oval in shape, elastic to palpation, and fluctuates at those points where the larger cysts are close to the surface. The new growth is separated by a capsule from the normal gland-tissue which is spread out on its surface. The epididymis is gradually attenuated by the growth, and eventually becomes indistinguishable from the capsule, though it remains free from disease. Adhesions between the gland and the enveloping scrotum form as progress is made, and between these some hydrocele fluid may appear.

Investigators are not unanimous as to the site of origin of the tumors, but the weight of opinion seems to be with Mr. Curling, whose careful researches led him to the conclusion that they spring from the rete testis. Both clinical observation and microscopic research have enabled pathologists to distinguish two forms of the disease, viz., the malignant and the nonmalignant, the observations of surgeons who noticed that some cases ran an unsatisfactory course ending in general infection, corresponding with the finding of sarcomatous and carcinomatous elements in the new formations.

The disease properly belongs to middle life. The mode of development is much like that of sarcoma of this organ, the patient usually referring the onset to some slight traumatism. Later on he observes that one testis is larger than is natural, that it is flattened laterally, and is causing a dragging sensation in the cord and even in the loin. The tumor is not painful, is smooth on the surface, with here and there a fluctuating point to indicate the presence near the surface of one of the larger cysts. The veins in the cord and scrotum enlarge as the growth slowly progresses. The increase in size is at an even rate, different from cancer, which advances by successive leaps.

**Diagnosis.**—It is impossible to distinguish, in the earlier stages, between the nonmalignant and the malignant cases, or to say at what period in the progress the change from the former to the latter takes place.

Besides the difference in the modes of development, there are other points that serve to assist in distinguishing cystoma. If one of the fluctuating points be punctured, the fluid contents of the cyst would issue and diminish the tumor at that point, while in the case of cancer blood would flow freely without lessening the size of the tumor. Cancer, besides increasing irregularly, is painful. Cystic tumor is not translucent, but is said to be heavier than a hydrocele and not so heavy as a malignant growth. Sometimes hard, cartilaginous nodules may be felt. Hæmatocele develops rapidly after a blow, and testicular sensation remains unchanged. It is often impossible to distinguish between this and cystosarcoma. It may be feasible to evacuate one of the cysts and examine the contents under the microscope, in which event the discovery of tessellated epithelium would render the prognosis more favorable; but the frequent association of carcinoma and malignant sarcoma with cystoma should render the prognosis guarded in any event.

**Treatment.**—The only treatment to be recommended is early removal; but in those rare cases where the non-maligancy is well demon strated, and where the patient has only one testis, one may follow the advice of Prof. Humphrey, of Cambridge, and carefully dissect out the diseased part only.

## DERMOID CYSTS OF THE TESTIS AND SCROTUM.

Cysts similar to those in other parts of the body, and containing skin, hair, bones, teeth, cartilage, etc., and even the gray matter of the brain, have been found, sometimes in the testis and at others in the sac of the tunica vaginalis as well as in the scrotal walls. Dermoid cysts of the testis may be intimately incorporated with the gland, or they may only push it to one side, causing its atrophy from pressure, or they may prevent its development. The tumor may become connected with the testis during fœtal life before its descent into the scrotum, while on the other hand it may develop in the scrotal wall and become subsequently connected with the testicle. The connection of the tumor with the testis before its descent may interfere with, delay, or prevent its transition.

The tumors are congenital, but may be small and attract no attention until the period of puberty, when the increased activity and growth generally bring them into prominence. The frequent traumatisms to which they are subjected cause inflammation, which may result in softening at certain points, and even in the formation of the fistula through which the fœtal structures composing them may be discharged.

**Diagnosis.**—The diagnosis is not, as a rule, difficult, though in some cases it may be impossible until an incision is made. The fact that the tumors are congenital is of the greatest importance. Puncture with a fine needle may discover bone or teeth, or these may be felt with a probe passed through a fistula, and the doubt cleared up.

**Treatment.**—The only treatment to be recommended is removal of the tumor. This should be done with as little interference with the testicle as possible. It is better to save even a part of the gland. There is no valid reason for removing a testicle because it is in a state of atrophy from pressure. It may develop under improved conditions. In case the tumor is intimately incorporated with the testis, or where the gland has been extensively invaded by repeated inflammations, its removal becomes necessary. In operating, the tumor may be exposed by an incision and dissected out from its bed without opening its capsule; or this may be split open, the contents removed, and as much of the capsule taken away as possible.

## SOLID TUMORS OF THE TESTICLE.

**Enchondroma.**—As a distinct disease enchondroma is rare, but cartilaginous growths in connection with other pathological states are tolerably frequent. The development of enchondroma testis is obscure and its growth is slow, requiring from four to six years.

The point of departure for the pathological process may be the interstitial connective tissue or the lymph-spaces of the gland. The rete testis is the most frequent site of the growth, though the epididymis may be primarily invaded. The size, shape, and character of the cartilaginous growths, as well as their appearance vary greatly, from the single round or oval nodule growing in the otherwise healthy gland-substance or epididymis to the most complex and varied forms. Occasionally fatty degeneration occurs in the new growth, followed by a cretaceous deposit in the intercellular substance.

It is often associated with other diseases, especially with the cystic, sarcomatous, and carcinomatous. When associated with fibro-cystic or carcinomatous growths, the tumor may attain a very great size. In medullary cancer the cartilaginous masses may be incorporated with the tissue, or they may be encapsulated. In cystic disease the nodules may be numerous, and scattered irregularly through the growth. Only when associated with other diseases does enchondroma appear to cause the testis to attain a very considerable size. Even when the disease appears in the form of a single nodule, some hydrocele fluid may be present which must be withdrawn to facilitate palpation, while, on the other hand, the disease may run its full course without hydropsy.

The tumor is oval in shape, heavy, and often has its surface studded with hard, cartilaginous nodules interspersed with fluctuating spots where softening has taken place. The cord is usually free of disease and the organ devoid of "testicular sensibility." There is absence of pain, the growth causing inconvenience only by its weight.

**Diagnosis.**—Diagnosis is beset with many difficulties. While one may—perhaps after tapping a hydrocele—detect a single hard and painless nodule, even in the substance of the gland, to determine its character would hardly be possible.

The slow progress of the growth, its weight, the absence of disease in the cord and of "testicular sensibility" in the gland when squeezed, are the chief points for differential diagnosis. The patient frequently refers the beginning to some injury to the organ, and urges the *post hoc* argument, as in sarcoma, cystoma, etc. Where the tumor continues to grow and to cause distress by dragging on the cord, the diagnosis remaining doubtful, an incision under strict antiseptic precautions, with the understanding that if found dangerously diseased the organ must be removed, would be justifiable. The tendency of these tumors to degenerate into other forms of disease capable of infecting the body—a fact long since called attention to by Rindfleisch and abundantly confirmed by experience—along with the inability of constitutional measures to cope with the disease, renders early removal the only treatment to be advised.

**Fibrous Tumors of the Testis.**—Diffuse syphilitic orchitis, when untreated, generally results in a fibroid degeneration of the gland which leaves only a lump the size of a small marble lying loosely at the bottom of the scrotal sac. This mass is composed chiefly of fibrous tissue, with here and there some wasted tubuli seminiferi in its meshes. The epididymis is generally included in the atrophy from pressure of the fibrous tissue. Interstitial, fibrous overgrowth is a not infrequent concomitant of various epididymal tumors. A hard fibrous knot at the tail of the epididymis following a gonorrhœal extension and blocking of the duct just where it begins to be a single tube, is quite common. When bilateral, these fibrous tumors are the efficient cause of an incurable *impotentia generandi.* A few cases are on record where very hard, bulky, and painless fibrous tumors have developed in these glands, the result of which has been enlargement instead of shrinkage; and this form has had no connection with syphilis as a cause. In all cases, however, the fibrous overgrowth seems to spring from the tunica albuginea and press inward at the expense of the secreting structures. This course seems to be pursued whether the organ increases or diminishes in size. In some few cases the fibrous growth is quite localized, resulting in the development, from the tunica albuginea, of a smaller fibrous mass imbedded in the secreting substance, and entirely indistinguishable by palpation from an enchondromatous lump.

In pure cases of fibrous tumor the cord and epididymis are left free of disease, and there is no hydrocele. "Testicular sensibility" is present or absent according to the extent of the glandular involvement. The slight tendency to become bilateral suggests a constitutional etiology, and raises the question whether syphilis, in some of its stages, may not have been overlooked in certain reported cases.

**Treatment.**—In doubtful cases the iodides may be tried in the beginning. Removal of the organ will rarely become necessary, and will generally depend on the size of the growth, the inconveniences it causes, the rate of its progress, and the amount of "testicular sensibility" as indicating the usefulness of the gland as a procreative organ.

**Calcareous Masses,** composed of phosphate and carbonate of lime and traces of magnesia mingled with animal matter, may form in the testis, epididymis, or cord, generally as a result of previous pathological changes. Fibro-cystic and cartilaginous growths sometimes undergo so-called chalky degenerations, but the great majority of these deposits are due to inflammatory processes in the chronic form. Tuberculosis stands at the head of the diseases producing this form of tumor. They are of stony hardness, variable in size and shape, and often mechanically irritate their surrounding capsules so as to produce inflammation and fistula. They are generally easily recognized, but in case of doubt a probe inserted through the fistula if present, or a needle through the tissues, will reveal their nature.

**Treatment.**—The treatment will depend upon the size and position of the concretion and the pain or inflammation it is causing. A small cretaceous mass encapsuled in the testis or epididymis, and causing no pain, may be left alone. In case mischief results in the way of abscess, fistula, etc., an incision should be made, the calcareous matter scooped out, and appropriate measures taken with a view of causing the cavity to granulate and fill up from the bottom. The actual cautery, after curetting, will be found to have a stimulating effect on the healing process. Small beadlike masses may form in the vas deferens and block the duct. They sometimes demand excision on account of the pain.

**Carcinoma of the Testis** occurs most frequently in middle life (thirty-five to forty-five), though cases have been observed in very young children as well as in the aged. The tendency to affect only one of the testes is a marked feature of the disease. Unlike almost all the other growths of the organ, the cancerous tissue is unmixed with other morbid products. It is most easily confounded, in the earlier stages, with cystic sarcoma and syphilis, and is entirely indistinguishable from soft sarcoma, a fact of no great practical importance, since early removal of the diseased organ is demanded in both cases. The growth infects the body by way of the cord and the lymphatic channels passing upward to the groin and abdomen. Butlin places the duration of the tumors at seven to forty-two months.

Two varieties of cancer of the testicle are distinguishable, scirrhous and encephaloid.

*Scirrhous* carcinoma of the testicle is very rare. It is of slow growth, and attains only a moderate size. The tumor is of stony hardness, irregular form, knotted, and rarely fungating. Sharp, lancinating pains accompany its advance, running up the cord to the loin. As the tumor develops, adhesions of the tunica vaginalis form, the glands above enlarge and press upon the veins, causing œdema of the leg, ascites, and gastric and intestinal disturbances, which, with the pain, render the patient cachectic.

*Medullary*, *encephaloid*, or soft cancer invades the body of the gland, causing a swelling, which in the early stage disturbs the fibrous tunic so as to render the testicle quite hard, though still lacking the stony feel of scirrhus. Later on it involves the epididymis. The disease advancing rapidly causes thinning of the tunica albuginea in places, changing the heretofore smooth and even outline to a softly nodulated appearance and feel. The most prominent portions fluctuate or become more elastic. Where the tunica albuginea is most thinned the growth may burst through, causing adhesion and finally penetrating the skin, protruding as a sloughing, foul-smelling, and bleeding fungus hæmatodes. There is no pain in the early stages, and testicular sensibility is abolished only as the normal epidydimal structures are replaced by the growth. As the cord is attacked, sharp pains shoot up toward the loin. The tumor is at first globular in shape, with sides flattened by pressure, but later on as the cord is affected it becomes more pyramidal. The distinct pear shape is reached when a hydrocele appears. Irregularity is given by the uneven thinning of the tunica albuginea and the formation of blood-cysts due to the traumatisms to which the large mass is naturally subjected. The tumor grows to a large size in a few months, sometimes equaling that of a fœtal head, the scrotal skin becomes thin and dark-colored, and the veins enlarge. Cancerous masses form in the cord, and general infection goes on. Dyspepsia and diarrhœa appear, and assist in rapidly wasting the patient's energies.

**Diagnosis.**—The differential diagnosis is not easy in the earlier stages. The disease is most readily confounded with syphilitic orchitis and soft or cystic sarcoma. The fact that the carcinomatous is unmixed with other growths, aids in distinguishing it from cystic disease where cartilaginous masses may be present. The chief distinguishing features of soft cancer of the testis are, the rapid enlargement without inflammatory symptoms, the size attained by the growth, the enlargement of the scrotal veins, and the development of cancerous masses in the cord. The limit of size for a syphilitic testis is that of the closed fist, while cancer grows much larger. Cancer is always unilateral, while syphilis is sometimes double. In the early stages doubt may often be removed by a carefully conducted antisyphilitic treatment. It is not advisable to puncture a cancerous tumor unless castration has been decided upon, for the reason that even a needle puncture is apt to cause a bleeding fungus to sprout. In case this is done, however, a cancer would bleed without diminishing in size. Between cystoma, cysto-sarcoma, and carcinoma, differential diagnosis is not of great practical importance, since early removal is equally desirable in all cases.

**Treatment.**—Early removal is the only treatment to be considered, and the question of castration will be decided by the extent to which the disease has involved the cord and the tissues along the line of general infection. When undertaken in time, excision has been found to give the patient a tolerably good hope. The difficulty of determining in any case the question of secondary infection will render the prognosis necessarily a guarded one in any case.

**Sarcoma of the Testis** appears under two principal forms, the round and the spindle-celled. There is no great or practical clinical difference between the two. Indeed, it is to the pathological histologists that we chiefly owe the distinction between soft cancer and sarcoma, for neither in their clinical histories, their physical or naked-eye appearances, nor in their malignancy, do they present any striking or easily recognized differences. We may therefore content ourselves here with mentioning those few and slight variations in appearance and clinical evolution which will in certain instances assist in differentiating them. Nor is this differentiation of great practical importance to the surgeon. The gravity of both cancer and sarcoma is such as to demand early removal of the diseased organ; and in other forms of tumor of the testis the known intermingling of sarcomatous elements adds greatly to the urgency of the case as well as to the guardedness of the prognosis. It is not, therefore, so much a question of distinguishing between sarcoma and carcinoma as it is of separating these from those nonmalignant diseases, such as syphilis, which not only show no tendency to infect the body, but are amenable to constitutional treatment.

**Diagnosis.**—Histologically, carcinoma is simple, while with sarcoma are often associated different abnormal structures mingling in the same tumor. Sarcoma most resembles medullary carcinoma, and this mingling of other structures may serve to give a valuable hint, which will enable the surgeon to separate the former both from cancer and syphilis. Cartilage, mucous tissue, and unstriped muscle-cells may mingle with a sarcomatous tumor in such a way as to give it a feel on palpation quite unlike the other affections mentioned. Unlike cancer, which is unilateral, sarcoma, like syphilis, not unfrequently affects both testicles. The round-celled variety is far more apt to be bilateral than the spindle-celled. In the matter of the ages of patients affected, Butlin noted only slight differences, the round-celled being most frequent before the age of ten months and between fifty and sixty years, while the spindle-celled variety was seen with equal frequency before the age of ten months, but appeared earlier in adults—that is, between thirty-five and forty-five. These differences so frequently overlap in the different forms as to render the observations of little value in given cases. The total duration of the spindle-celled variety was noted, by the same author, to be longer. The spindle-celled tumors seem to show a less active malignancy than the other, being more frequently combined with other morbid growths—cartilage, muscle-cells, etc.—less liable to affect both testes, and not so prone to involve the lymphatics in anatomical relationship. They also more rarely result in extensive generalization in distant organs. The lungs, among the distant organs, are liable to become involved.

The growth of the tumor without inflammatory symptoms, its shape, the size attained, and the appearance of the scrotal envelope so closely resemble those of carcinoma as to render differentiation difficult in all and impossible in the majority of cases. This resemblance is in all respects so close as to render it unnecessary to repeat here the method of distinguishing between cancer and syphilis.

**Prognosis and Treatment.**—Early removal of the diseased organ offers the only hope, but the prognosis should be guarded in any event. It is sometimes desirable, for the comfort of the patient and to minimize his sufferings and the task imposed upon his friends, to operate even after the cord and the lumbar glands are involved in the disease.

## EXCISION OF THE TESTIS.

The influence of anæsthesia and antisepsis has been to entirely revolutionize this surgical procedure, enabling us to proceed step by step and at leisure, advantages denied our predecessors. Sir Astley Cooper's brilliant method of removing the gland with a part of the scrotum by one stroke of the catlin went out of vogue when anæsthesia came in, and the same may be said of the method of first tying the cord through a button-hole before exsection was begun. The preparation of the patient is now a matter of the first importance. The skin over the pubes, scrotum, perinæum, and inner aspect of the thighs is washed in soap and water, carefully shaved, and covered for an hour or so before operation with towels soaked in a bichloride solution 1 to 2,000. The patient should be placed on a narrow table of convenient height and anæsthetized. The parts are again washed with bichloride solution, and the parts of the body immediately surrounding the field of operation shut off with the bichloride napkins. It is of importance to cleanse the perinæum and penis carefully, and have the latter kept away from the neighborhood of the wound by an antiseptic towel. The operator then seizes the tumor with his left hand passed beneath it, and puts the scrotum moderately on the stretch. The incision will vary according to the size and nature of the growth. In moderate-sized tumors there is no necessity to begin the incision at the external abdominal ring, but where the cord is also involved this may be advisable; but, begin where it may, it should be carried to the bottom of the sac to secure drainage. My own preference is to begin over the top of the tumor, going through the layers of the scrotum stroke by stroke with a very sharp knife. Thus one may decide whether it is necessary to divide the tunica vaginalis at all or to remove it entirely after separating it from the other coverings. The gland being exposed, it may be turned out, the mesorchium divided with scissors or knife, and then, the finger being thrust up the cord as a director, the incision may be prolonged as far as necessary. The cord, carefully separated from its coverings, may now be examined. It should be left to the last, lest the discovery be made that, owing to an error in diagnosis, the testis may be saved. Removal being decided on, a medium-sized silk ligature should be passed through its center, and the funis divided about a quarter of an inch below it. Thus retraction with bleeding, necessitating the opening of the inguinal canal, may be prevented. The vessels are now to be tied separately, the looped ligature being relaxed so as to favor their detection. The artery of the vas deferens should be sought out and tied whether it bleeds or not, otherwise secondary hæmorrhage may occur some hours after the patient has been put to bed. Some operators divide the cord with clamp and cautery, following the plan of Mr. Henry Smith, of London. The objection to the ligature of the cord *en masse* is the pain it gives and the difficulty with which the thread comes away.

All bleeding having been stopped, and as much of the scrotal sac having been removed as seems necessary, the ligature that has been passed through the cord and tied in a long loop is now brought out at the upper end of the incision, a decalcified bone drainage-tube (or one of rubber) is placed in the bottom of the sac, extending from the cut end of the cord and out of the bottom of the scrotum; the skin is now brought accurately together over it by a continuous suture of catgut. Good drainage should be looked after, and care should be taken to prevent any turning out of the dartos between the stitches. These, if not corrected, sprout exuberant granulations and retard healing. The line of the incision may now be covered with a thin strip of cotton web in a 1-to-2,000 bichloride solution, the parts enveloped in the same material, and the whole neatly secured by bandages passed round the hips and between the thighs. This bandage adds to the comfort of the patient by permitting him to turn in bed, which he can not do if the sac is supported on a small pillow. In applying the bandage, care should be taken to leave the cotton covering the end of the drainage-tube free and loose, to prevent its being blocked by pressure when the cotton becomes wet. The bandage should be so applied as to permit the bowels to be moved without soiling it. Properly adjusting the pressure, it is possible to prevent much of the swelling of the loose scrotal tissue that takes place when the pillow is used. The dressing may remain for four days, and the anchor loop in the stump of the cord need not be disturbed until the change is made.

When, on account of its being adherent, diseased, or redundant, any part of the scrotum the surgeon desires to remove may be included between two semilunar incisions, which meet above and below. If an inguinal hernia complicates the disease, the opportunity may be taken advantage of to put into practice suitable methods of radical cure.

In case the testis is retained, an incision may be made over its site in the canal or even higher up. In either event it is necessary to open the peritonæum. Since the surgeon can never say whether peritoneal cavity must be invaded, all the steps of the operation should be antiseptically guarded.

## IRRITABLE TESTIS.

*Irritable Testis* must be distinguished from neuralgia of that organ, a task not difficult to accomplish. The acute, darting, and paroxysmal, or the continuous dull and dragging pains of neuralgia, unrelieved by rest and recumbency, are quite unlike the simple but extreme sensitiveness of irritable testis.

In irritable testis the whole organ, or more frequently a particular spot, is exquisitely sensitive to the slightest touch, even contact of the clothing being in some cases unbearable. The patient may be robust and healthy. The disease occurs at any time between early puberty and the latter part of middle life, when the sexual powers decline. It is not met with in those who have flabby testes and relaxed scrotal sacs any more frequently than in those with tense sacs and plump glands. It is often bilateral, while neuralgia is almost always one-sided. The nervous, the anæmic, the neurasthenic, are not more apt to have it than the ordinarily healthy person. There does not seem to be any relationship of effect to melancholia, dyspepsia, oxaluria, or central disease of the nervous system, neither do disseminated tubercular nodules, nor localized syphilitic lesions, have any recognizable causative connection.

The etiology is in the highest degree obscure. The fact that it is often bilateral, that it belongs to the active period of puberty, that it occurs most frequently in cases of over-stimulated and ungratified sexual desire, and in those whose normal sexual habits have been suddenly interrupted, as well as the quite common involvement of only a small portion of the testis, all point to a perversion of nutrition of the peripheral nerves. This may well be so in an organ presenting the physiological peculiarities of the glands of reproduction. There are no observations of the histological changes in the diseased areas reported, and in the pure cases no anatomical alterations are discernible on physical examination.

**Treatment.**—Sexual hygiene, which means marriage, stands at the head of curative means. Fornication, to which no physician would give his consent, aggravates the disease. In one case that came under my observation the patient had broken off an engagement to marry on account of the disease, and in sheer desperation had flung himself into a life of sexual excess, with the result of greatly increasing his trouble. He recovered soon after being married to the woman of his choice. When marriage can not be advised, as in the case of persons who are too young, rest in bed, the protection of the organ by suitable apparatus from rough contact, and the application of an evaporating lotion, constitute our most effective means of relief. The following is an excellent lotion : ℞. Liq. ammon. acetatis., ℥ j ; spts. etheris nit., ʒ jss. ; aquæ camphoræ, ʒ iijss. M. Sig. : Apply locally on thin muslin, kept constantly wetted. The ordinary antineuralgic remedies are not to be relied upon. Sulfonal, phenacetin, and antipyrine should be tried before giving opium or its alkaloids to relieve suffering.

# HYDROCELE AND SPERMATOCELE.

By JOHN A. WYETH, M. D., and W. W. VAN ARSDALE, M. D.

**Definition and Nomenclature.**—The term *hydrocele* is employed to denote an accumulation of fluid in the serous sac of the testicle, the fluid being the natural secretion of serous membranes.

Since the serous sac of the testicle is a part of the pouched duplicature of the peritonæum, known as the vaginal process, not obliterated after the descent of the testicle, the term hydrocele may be applied, in conformity with the above definition, to any part of the process containing an unusual amount of serous fluid.

Generally, however, the term hydrocele, unless specially characterized, is used to designate the accumulation of an abnormal amount of serous fluid in the tunica vaginalis testis alone—the rest of the processus vaginalis being obliterated in the adult, in the normal state of development, in from ten to twenty days after birth.

Synonymous with the word hydrocele, when used in the latter, more special sense, are the terms periorchitis, orchidomeningitis, vaginalitis, which intimate that the condition in question is of inflammatory origin. As we shall show later on that inflammation does not always play a part in bringing about the affection, we use the term hydrocele in this article by preference.

*Hydrocele processus vaginalis peritonei* may be variously classified, according to its extent and location. When hydrocele is congenital, the tunica vaginalis frequently communicates with the peritoneal cavity; or, in other words, the vaginal process remains open, leading into the peritoneal cavity. This form has been called *hydrocele communicans.*

In contradistinction to this variety of hydrocele, the usual form of effusion into the tunica vaginalis has been called *incapsulated hydrocele of the testicle.*

An accumulation of fluid about the spermatic cord is termed *hydrocele funiculi spermatici*, or *perispermatitis.* The effusion may be located in the sheath of the cord not obliterated after the descent of the testicle, in which case it is called incapsulated "*hydrocele funiculi saccata.*" This form may communicate with the peritoneal cavity: *hydrocele funiculi communicans.* Or the effusion may not be confined to the serous sac representing the sheath of the cord, but may be located in the cellular tissue enveloping the cord and its sheath. This form has been termed *diffuse hydrocele of the cord;* it is exceedingly rare, and is of slight practical interest.

We must here mention two other variations in the location of accumulations about the testicle, for the sake of completeness, although but little practical interest attaches to them. An effusion of fluid may take place between the tunica vaginalis and the tunica albuginea testis. Again, we may have an accumulation of fluid between the fibrous layers of the tunica vaginalis communis, which, when present conjointly with hydrocele of the tunica vaginalis testis, represents one of the two forms of *bilocular hydrocele.*

The other form of bilocular hydrocele is the combination of hydrocele of the tunica vaginalis and one along the course of the cord, not communicating with the peritoneal cavity, but sometimes extending *extra peritonæum* toward the abdominal integument.

Both of these forms of bilocular hydrocele may be regarded as a simple hydrocele of the tunica vaginalis with a diverticulum, the direction only of the expansion of the diverticulum differing in the two cases. The two sacs in the bilocular hydrocele generally intercommunicate through a more or less well-defined aperture; so that the fluid may be forced from one sac to the other by pressure.

*Multilocular hydrocele* is a collection of encysted accumulations of fluid, not intercommunicating, lying most generally at the original site of the vaginal process of the peritonæum.

These various forms of hydrocele admit of combination and complications in great variety—complications with cysts, hydatic or embryonic, in the region of the head of the epididymis, and with hernial sacs, being the most frequent and important.

*Clinically* we must differentiate between acute and chronic hydrocele; such a distinction being important, not only in regard to the origin and pathology of the affection, but especially of practical value as influencing the treatment.

## ACUTE HYDROCELE.

**Pathogenesis.**—In by far the greater majority of cases of acute inflammatory affections of the epididymis, and in many cases of those of the testicle, we find a concomitant hydrocele present. This is very frequently overlooked, and the more readily as no very great importance attaches to its presence. Pathologically these acute serous effusions into the tunica vaginalis are comparable to the secondary pleuritic effusions complicating pneumonia.

An acute hydrocele may further result from traumatisms of the scrotum or its contents, or the urethra or bladder. Thus, contusions of the testicle or epididymis, septic infection of wounds of the scrotal coverings, the passing of instruments into the urethra or bladder, frequently produce acute hydrocele. Inflammations of the urethra, the prostate, the bladder, or the inflammation of other serous membranes of the body, also lead to the development of acute hydrocele.

Most frequently this affection is associated with epididymitis; and it may appear in pyæmia, variola, and spontaneously, in epidemics, secondary to epididymitis.

**Etiology and Pathological Anatomy.**—The acute inflammations of the tunica vaginalis are now generally considered to be most frequently due to organized infectious agents, although it must be conceded that any irritation capable of exciting inflammation, such as chemical agents, heat, etc., may cause acute hydrocele; any agent, in fact, capable of injuring the structure or the functions of the serous sac of the testicle.

These inflammations may vary in character, as in other parts of the body, the "serous" inflammation due to simple hyperæmia of the sac walls and hypersecretion being the most frequently observed; while the "adhesive" variety of inflammation, consisting in the formation of fibrinous masses in the cavity of the tunica vaginalis (periorchitis plastica), and the "suppurative" variety, generally attributed to the invasion of pyogenic micro-organisms, are of much rarer occurrence.

The serous membrane appears red and injected, the microscope showing the capillaries enormously distended and filled with blood. The surface is less smooth and glossy than normal, the epithelium having disappeared, and emigration of leucocytes having commenced. A soft, pinkish, elastic substance is sparsely distributed upon the portions of the surface of the membrane, and frequently forms connective filaments between portions of the serous membrane. Similar flaky masses are also to be found floating in the serous exudate inclosed in the sac.

Thus, hyperæmia and exudation are the two chief symptoms found in the first stages. Later on these inflammatory changes may develop new-formed connective tissue, as in the adhesive form of inflammation, or end in suppuration. At the commencement of the latter form of inflammation the serous surface appears coated with a milky-white membrane at a time when the serous effusion is still quite clear and transparent. At a later stage the fluid becomes turbulent through the entrance into it of pus-cells; finally, it turns into pus.

**Pathology.**—The commencement of acute hydrocele is sudden and accompanied with fever, which, however, may be slight or not appreciable. Pain is frequent over the site of the swelling and along the cord. On pressure the pain increases, the caudal region of the epididymis being the point of greatest sensitiveness. Frequently the scrotal integument is reddened and œdematous.

The character of the swelling is that of chronic hydrocele. The form is oval or pear-shaped, and fluctuations can be detected, but the tenseness of the tumor is much more marked in the acute effusions. In consequence of the greater pressure within the sac, the oval form of the tumor is apt to appear laterally flattened.

If the inflammation takes on a suppurative character, the clinical symptoms become somewhat changed—continuous fever, rising toward night, and more severe pain are present, and a more marked phlegmonous condition of the skin of the scrotum, ending in the formation of an abscess and perforation.

**Course.**—If, on the other hand, the inflammation does not go on to suppuration, the affection reaches its height on about the third or fifth day, when the fever abates and the effusion is gradually absorbed. In one or two weeks the patient has generally entirely recovered. Or the hydrocele may become chronic. In the adhesive variety of inflammation thickening of the walls may be noticed, and obliteration of the sac may be effected.

**Diagnosis.**—The diagnosis of acute hydrocele is not always easy. The most simple cases are those where we have induced acute inflammation in the sac after tapping for chronic hydrocele by injecting irritating substances, such as carbolic acid.

In other cases the differential diagnosis between hæmatocele, epididymitis, orchitis, and hernia must be made. As hæmatocele is frequently caused by traumatisms, this may easily be mistaken for acute hydrocele. The absence of fever, a lesser degree of translucency, and aseptic aspiration by means of a hypodermic needle, will determine the diagnosis in important cases, while in those cases where a hernia has suddenly appeared the continuation of the tumor into the inguinal canal and the abdominal cavity will point to hernia. Acute hydrocele is so frequently connected with epididymitis that the presence of the latter should always be suspected and sought for. The diagnosis of epididymitis is made by recognizing the long-shaped, hard, non-fluctuating body of the epididymis, behind the testicle, and continuous with the cord. Pressure of this body causes acute pain.

Orchitis may be distinguished from acute hydrocele by the absence both of fluctuation and of translucency, while the hardness and weight are more marked, and the symptoms of inflammation in the scrotal coverings are absent.

**Prognosis.**—The prognosis of acute hydrocele is generally favorable. Even when the suppurative form is observed, the proximity of the focus to the common integument is so great that there is little danger to the system, even when the abscess is not interfered with, especially if the scrotum is not subjected to pressure from without. In the other forms of the disease the greatest menace consists in the affection becoming chronic; this issue is, however, comparatively rare. Concomitant hydrocele, coexistent with epididymitis and inflammations of other organs, has the same prognosis as the primary disease.

**Treatment.**—Many cases of acute hydrocele recover without treatment; especially in the epidemic variety of disease, the patients frequently get well without being obliged to neglect their daily vocations. Rest in the house is, however, advisable in the first days during the febrile stage; elevation of the affected parts, application of cold, and judicious compression, are beneficial in less severe cases. General and local depletion, the application of leeches at the external ring of the canal, may be resorted to.

Aspiration of the exudate is best deferred until the febrile reaction is past, and is generally unnecessary. The exhibition of potassium-iodide solutions internally has been recommended.

In two or three days the patient may generally be allowed to go about with a well-fitting suspensory bandage.

In all cases of suppurative inflammation of the sac of the tunica vaginalis early incision with drainage should be insisted upon. This operation should be done under cocaine anæsthesia and with due antieptic precautions. The patient should remain in bed until the wounds is healed, and wear a suspensory bandage for some time afterward.

## CHRONIC HYDROCELE.

When the term hydrocele is used without any additional explanatory epithet, chronic hydrocele is implied. This variety is most common, and very frequent, occurring at all times of life, and on either side with about equal frequency, and often simultaneously on both sides.

Heredity has no influence in the causation of hydrocele proper. Hydrocele was well known to the ancients, and was accurately described by Celsus. Chronic hydrocele generally develops in the course of two or three weeks. It shows no tendency to disappear spontaneously, but increases more or less rapidly and constantly in size.

**Etiology.**—The etiology of the affection is considered to be a discrepancy between the amount of fluid secreted by the tunica vaginalis and that absorbed. *A priori* we should expect to find hydrocele present as well in inflammatory conditions when a larger amount of exudation of serum takes place, as also in those cases where the absorbent mechanism is interfered with. This latter alternative is, however, excluded by clinical observation; for in those cases where dropsy of the serous cavities in other parts of the body is observed, as in hydrothorax, hydropericardium, and ascites, hydrocele is never present, and not even then, when œdema of the scrotal integument is very pronounced.

We must therefore have recourse to the inflammatory theories for an explanation of the etiology of hydrocele. But here we meet with another difficulty, for in many cases we are not only not able to explain the anatomical conditions present in hydrocele on any basis of inflammatory changes, but we frequently have occasion to observe the development of hydrocele without any concomitant symptoms of an inflammatory character.

*Virchow*, *Klebs*, and other authors in pathology have made a study of hydrocele, and have failed to find any inflammatory conditions present. The forms of congenital hydrocele exclude the idea of inflammatory changes as etiological factors in the causation of the affection.

There is also a variety of hydrocele known as senile hydrocele, where the disease develops spontaneously late in life, but without any inflammatory conditions whatever.

It is true there do exist cases where the cause of hydrocele may be traced properly to an inflammation—cases where the origin of the disease can be traced to a blow upon the scrotum, or some other traumatism of the neighboring parts; and in many cases we can trace the development of hydrocele to inflammatory conditions existing in the epididymis, the testicle, the spermatic cord, the urethra, or the bladder. But in all these cases we recognize the conditions mentioned above as causing acute hydrocele; so that we may represent the actual facts more correctly by stating that acute hydrocele may become chronic.

We have mentioned above that in acute hydrocele exudations and fibrinous masses on the surface of the tunica vaginalis were not uncommon. It is not improbable that chronic hydrocele owes it existence to the presence of such proliferations and excrescences of the walls of the sac. Similar conditions are met with in other serous cavities. Moreover, small cysts, the perseverance and enlargement of the embryonic cyst, known as Morgagni's hydatid, are known to be a frequent cause of chronic hydrocele.

If we exclude inflammation as an important factor in the etiology of chronic hydrocele, we must also properly exclude from the nomenclature such terms as "periorchitis," designating an inflammatory condition.

**Pathological Anatomy.**—In chronic hydrocele the walls of the sac show the most important morbid changes; but they differ considerably in various conditions. In most cases the walls appear considerably thickened, and the more so, as a rule, the older the hydrocele is. The layers of the sac wall consist of sclerotic connective tissue, frequently indurated to the consistency of cartilage. Calcareous formations and even localized osseous deposit may here be found.

The epithelium is but little impaired, and this condition is the chief characteristic point of interest in chronic hydrocele; it appears whitish, but the surface of the membrane retains its gloss.

The fluid contents of the hydrocele next engage our attention. The quantity formed varies with the size of the tumor; as much as twenty-six quarts is said to have been evacuated at one time. The average in the cases met with in general practice ranges between eight ounces and a quart.

The color of this fluid is generally a pale straw or amber; but it may vary considerably, and present a greenish-brown or chocolate or opaque appearance. Most frequently it resembles serum, and is clear and transparent. Its consistency may be considerably greater than that of serum, however. Not infrequently it is gelatinous and ropy. If pus is present, in cases of beginning inflammation, the fluid is rendered opaque. Spermatozoa cause an opalescent appearance; blood even in small quantities is easily detected by the color. The fluid shows a neutral or alkaline reaction; the specific gravity generally ranges between 1,020 and 1,026. Chemically it contains large amounts of albumen, very frequently the addition of nitric acid causes the entire mass to coagulate.

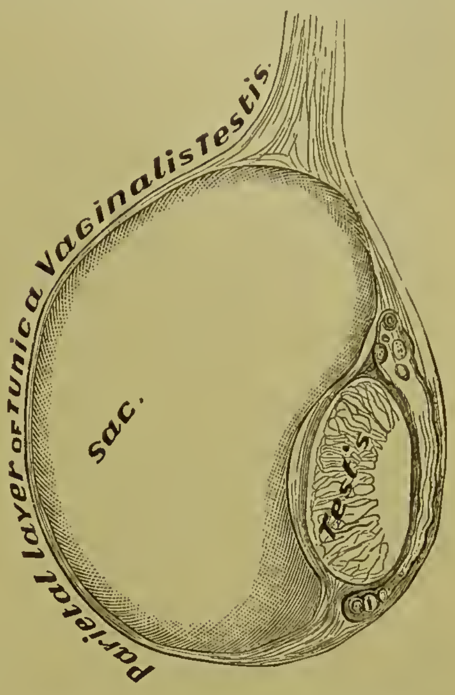

Fig. 1.—Usual form of hydrocele. (After Kocher.)

The morbid anatomical conditions described thus far under this heading are those of hydrocele proper, or of chronic accumulation of fluid in the tunica vaginalis.

Opposed to these conditions are those forms of chronic inflammation of the tunica vaginalis which may properly be termed chronic periorchitis. But we may, with advantage, consider these forms at this point for the sake of brevity, and especially since the clinical symptoms and the treatment of both classes of the chronic forms are practically the same.

We must, however, for the sake of greater clearness briefly refer to some theoretical points in the pathology of the subject. There are authors who insist that all chronic accumulations of fluid in the tunica vaginalis are inflammatory in origin (Rindfleish), and who regard hydrocele as analogous to ependymitis ("hydrops inflammatorius"). These authors have no difficulty in explaining the various forms of chronic hydrocele: they regard them simply as variations in degree as well as in quality of the inflammation.

Another class of writers, however, who hold, mainly from the reasons presented above, that hydrocele proper should not be classed among the inflammations, are put to the necessity of drawing a line which should separate chronic hydrocele from the less pronounced cases of periorchitis serosa chronica. There is no doubt but that these two forms gradually pass over into each other, and can not be definitely limited.

The salient point of difficulty in this question lies in the correct appreciation of the difference between hypertrophy and inflammation. Pathologists have ever insisted and agreed that a distinction should be made between these two conditions. But as our knowledge advances, the tendency to regard inflammatory conditions as reparative action in the tissues becomes more pronounced; and from this point of view the differentiation between hydrocele and periorchitis chronica appears tenable.

*Periorchitis prolifera* differs from hydrocele in the amount of thickening which the walls of the sac undergo. In well-marked cases large masses of newly formed fibrous tissue are found composing the sac walls, while the amount of fluid inclosed in the cavity is small, and the tumor is consequently not generally of large size.

In extreme cases there may be no fluid at all present, and the entire tumor may be due to the enormously increased and thickened tunica; in these cases the tumor resembles a chondroma more than aught else, and may be mistaken for a malignant neoplasm. In less well-marked cases, where there is more accumulation of fluid and less hyperplasia of the walls, the distinction can not be satisfactorily made between hydrocele proper and the inflammatory condition under discussion.

The surface of the tunica in periorchitis prolifera is usually found irregular; excrescences similar to synovial villi are found, which become harder with age and frequently undergo calcareous degeneration. Indeed, free bodies, consisting of sclerosed connective tissue of cartilaginous structure, sometimes ossified in the center, are found in the latter stages. The proliferation of connective tissue may not be restricted to the serous membrane alone, but may take place in the connective-tissue layers externally to it, and may grow about and through the epididymis, strangulating it and causing its atrophy. Indeed, the testicle itself may also be squeezed between two layers of proliferated connective tissue and be destroyed.

In *periorchitis adhæsiva* the epithelium is destroyed, and the internal surface of the tunica vaginalis is covered with an organized exudate originating from the serous membrane, and varying in form and thickness. When both walls of the cavity are attacked, they become attached and may grow together. This generally occurs within limited areas, and bands and circumscribed adhesions approximate the opposite walls. In certain cases the entire cavity may be obliterated.

Another form of chronic inflammation has been described under the name of

*Periorchitis Hæmorrhagica.*—In this case the surface of the tunica vaginalis is covered with newly formed membranes of connective tissue which are highly vascularized, and which bleed spontaneously from time to time. The aspect of the effusion into the sac of the hydrocele is affected by these hæmorrhages, the color becoming darker and the consistency greater, and the tension within the sac may be considerable.

Kocher describes this form in connection with periorchitis prolifera.

It is this form of hydrocele which is generally described in the literature as chronic hæmatocele; the term acute hæmatocele being used to designate the hæmorrhage into the tunica by the rupture of a blood-vessel (" hæmatoma tunicæ vaginalis ").

*Suppurative inflammation* is induced when the exudate from the serous membrane, instead of becoming organized, becomes infected by pyogenic micro-organisms and secretes large numbers of pus-cells, or when (according to the more recent theories) the coagulation of the inflammatory exudate is prevented from taking place by the presence of certain chemical agents or ptomaines. The internal aspect of the tunica vaginalis appears ulcerated, and large masses of the newly formed membrane are thrown off and undergo suppuration. The destruction of tissue is checked in certain places by the formation of a granulating surface (" pyogenic membrane ") ; in other places the inflammation progresses, by invasion of the infectious agents into the tissue, till the abscess is said to point externally, and spontaneous perforation of the skin ensues.

**Pathology.**—The commencement of chronic hydrocele is insidious and painless ; in those cases only where chronic hydrocele develops from acute hydrocele can it be said to be associated with acute pain ; the sensation of weight is the symptom most generally complained of by the patients, and drawing pains in the spermatic cord may occasionally become associated with it, especially at such times when the hydrocele suddenly becomes enlarged. Such exacerbations are more acutely felt when the walls are thickened and present more resistance to the increasing fluid contents of the sac.

The development of hydrocele usually takes place from the lowest point of the scrotum upward. The testicle is generally dislodged toward the posterior aspect, where it may be recognized by means of the spermatic cord leading to it, and distinctly felt.

**Symptoms.**—When after the course of three or more weeks the hydrocele has reached its full development, it generally presents the following symptoms :

Situated within the scrotum, generally unilaterally, is found a fluctuating, oval, pyramidal, or pear-shaped tumor, which usually bears a well-marked and constant topic relation to the testicle. It is most frequently recognized in the front of the testicle and in the upper portion of the scrotum, just below the point where the skin of the scrotum joins that of the penis.

The fluctuation is most pronounced in the early stages of hydrocele; in old cases, where the walls are thick and where there is very great tension, as in cases of rapid development, it may be almost imperceptible. The shape is liable to undergo great changes. When it is pear-shaped the base is situated below and the apex above, pointing toward the inguinal canal. Very frequently, however, an elongated oblong form is found, or a perfectly round one. In cases where adhesions of the sac wall have occurred the shape may be most irregular and complex.

In children, hydrocele more frequently extends along the course of the spermatic cord. The surface of the tumor is smooth; no irregularities or roughness is encountered by passing the finger over it.

The consistency of the tumor is not the same in every part, the region where the testicle is located being uniformly harder to the touch than where the fluid lies nearer to the outer skin. The seat of the testicle, although generally at the posterior aspect of the tumor, as mentioned above, may vary with the following causes:

The developmental anomaly known as inversion of the testicle causes it to lie in the anterior region of the hydrocele. In this case the examination of the testicle on the sound side will indicate the anomaly and point out where to look for the testicle in the hydrocele.

Again, wherever adhesions have formed within the sac of the tunica vaginalis the testicle may be dislodged from its proper position and drawn to any portion of the tumor. In certain cases the epididymis with the vas deferens may be separated to a greater or less degree from the testicle, especially when the hydrocele is complicated with diffuse hydrocele of the spermatic cord, and give rise to errors in diagnosis, unless this condition is properly appreciated. In determining the position of the testicle in the hydrocele (which is important from a therapeutical point of view), it is advisable not to rely solely upon the sense of touch, but also to make use of the translucency test.

The testicle itself is generally in a sound condition. In the case of chronic inflammatory hydrocele mentioned above as periorchitis prolifera, the testicle may be compressed, anæmic, or atrophied; most generally the tail of the epididymis is affected, and the vas deferens may be compressed.

The most important symptom characteristic of hydrocele, and the one which enables us to differentiate it from other conditions simulating hydrocele, is its limitation in the inguinal canal or below it.

The tumor is sharply defined above; so that the spermatic cord can be readily felt above the tumor, near the external ring, and moved laterally between the thumb and forefinger.

The weight of the scrotum in hydrocele is heavy to the feel, but not so much so as in some cases of orchitis.

Change of position of the patient, from the erect to the recumbent does not influence the usual form of hydrocele in any way. Only in case of communicating hydrocele, or when a branch of the sac extends far up into the inguinal canal, does posture affect the aspect of the tumor.

The general integument covering the hydrocele is attenuated, especially in large hydroceles. The veins frequently appear dilated and dark-colored. The skin is often drawn away from the surrounding parts by the growth of the tumor; and as a consequence of this the penis may appear shorter, or sometimes disappear from view altogether. The cremaster muscle is often found hypertrophied in cases of long standing. Œdema of the skin of the scrotum is never present in uncomplicated cases of hydrocele. In cases of extreme tension of the skin in elderly patients, gangrene may occur.

Finally, the translucency of the tumor must be mentioned, a test which is not always reliable, but of considerable differential diagnostic importance. The test of transparency is best made by means of a three-fourths-inch tube, or the tube of a straight stethoscope. The patient should be so placed that the scrotal tumor is situated between the observer and the light. Either the prone or standing posture may be employed, and a lighted candle does good service for illumination.

We here add the symptomatology of the other various forms of chronic hydrocele mentioned above as inflammatory in character, and more especially that of periorchitis prolifera.

In *periorchitis prolifera* the thickening of the walls may be so marked that no fluid can be felt through them, and consequently all the symptoms of a solid tumor may be present. In any case, however, the tumor is sharply defined above. Fluctuation may therefore be absent, or scarcely recognizable. The shape is oval or pyramidal, pear-like; in well-marked cases, irregular; the superficies being uneven or nodular. The irregularities may be so pronounced as to suggest the use of the synonymous term periorchitis deformans.

The consistency and weight of the tumor are considerable, and more pronounced in the older cases. The testicle may not be recognizable by the touch, being imbedded in the hard, fibrous tissue or destroyed by pressure. On the other hand, we may recognize one or more floating bodies within the tumor.

The skin of the scrotum is not altered; in exceptional cases, where the tumor has reached a large size, it appears stretched and attenuated.

The tumor is not translucent.

When hydrocele goes on to *suppuration* from any cause, we encounter the usual symptoms of acute inflammation, pain, fever, redness and swelling of the skin, and local heat. The pain is augmented by pressure, and extends along the spermatic cord to the back. Fluctuation is well marked, the general consistency of the tumor varies in places, and is soft where the abscess points.

The tumor loses its translucency in the later stages, and the contents of the sac are puriform.

The *general clinical picture* of hydrocele is that of a benign tumor. The patients are usually in robust health; they have no pain, and are not prevented from attending to their daily vocations, unless it be by a sense of weight. This causes them, in well-developed cases, to move about more slowly.

The *course of the disease* is a chronic one, and unless surgical interference is employed the size of the tumor steadily but slowly increases, until some occasional violence causes its rupture. In certain cases the hydrocele may remain stationary.

Acute inflammation may attack hydroceles, induced either by external traumatisms or as an exacerbation of the initial causative process. Such intercurrent inflammatory crises cause enlargement of the tumor and thickening of the walls. Indeed, the growth of all hydroceles has been attributed entirely to these exacerbations by some authors. Very rarely does it happen that hydroceles go on to spontaneous suppuration, this course being limited to infection from neighboring wounds or that of the entire system with pyogenic material. Suppuration generally leads to the destruction of the sac, and frequently to that of testicle as well. Spontaneous recovery, on the other hand, is more frequent, the fluid being absorbed from unknown causes. The hydrocele may recur, however.

Rupture of the sac has been observed, after traumatisms, with effusion of the fluid into the cellular tissue surrounding the sac, and consequent absorption, and this accident is said to happen frequently to riders on horseback.

The occurrence of an acute epididymitis has also been observed to cause a hydrocele to disappear. And, lastly, confinement in bed and rest has in some instances had the same result.

**Diagnosis.**—The *diagnosis* of hydrocele can generally be made by palpation alone. We begin by examining the testicle on the sound side, in order to facilitate comparison with the affected side. The next step is to get satisfactory evidence of the limitation of the tumor in the scrotum. This is best achieved by grasping the spermatic cord between the thumb and forefinger at the point where it passes out from the tumor, and before it enters the inguinal canal. By means of this we can exclude herniæ and epididymitis; for in hernia, even when it is strangulated, the tumor is felt to be continuous into the abdominal cavity, while in epididymitis the cord is most generally swollen.

If we are able to prove the limitation of the tumor in the scrotum, the next step is to endeavor to establish fluctuation. If we find that the tumor fluctuates, the diagnosis lies between hydrocele, hæmatocele, and abscess.

Freedom from pain and absence of participation of the skin enable us to rule out abscess, and the test of translucency decides between hæmatocele and hydrocele. The only error in diagnosis now possible is the mistaking of some cystic tumor, other than hydrocele, for an effusion into the tunica vaginalis. In such rare cases the location of the testicle, as well as the history, must decide.

In case no fluctuation is established, we must bear in mind orchitis, solid tumors of the testicle, and those forms of periorchitis prolifera which possess very thick walls and little fluid under considerable tension.

Fever and rapid development point to orchitis, while tumors are readily recognized by their development from below upward—hydrocele developing in the opposite direction. Malignant tumors impinge upon the tissues of the skin of the scrotum at an early date.

Aseptic aspiration of the tumor with a hypodermic needle will decide the question in cases of difficult diagnosis. The history of syphilis in a patient with scrotal tumor may point to chronic orchitis as well as to periorchitis prolifera, while tuberculous diathesis is more indicative of epididymitis.

Thus far we have assumed the tumor to be well defined above, and not to extend toward the inguinal canal. If the tumor is found to extend into or through the canal, it becomes necessary to differentiate it from hernia, varicocele, and the various other forms of hydrocele. The reader is referred to page 288 for more detailed *differentiation* in these cases.

**Prognosis.**—The *prognosis* is favorable in hydrocele, both on account of the benign nature of the effusion and the relative freedom from danger of the surgical methods generally employed for its cure.

In cases where surgical interference is declined, the prognosis should be given in accordance with the remarks made above concerning the course of the disease.

Special forms of chronic hydrocele, however, may alter the prognosis considerably. *Periorchitis prolifera* is apt to cause atrophy of the testicle from pressure, and can not be cured without graver surgical interference than that which is called for in hydrocele. *Periorchitis adhesiva*, on the other hand, is liable to result in spontaneous cure.

The prognosis of suppurative inflammation in the tunica vaginalis is identical with that of abscess in synovial membranes; if early incision and drainage are practiced, the outlook is favorable for a permanent cure.

**Treatment.**—The treatment of hydrocele proper is based upon the recognition of two principles: firstly, the regulation of the existing balance between secretion and absorption in the sac of the tunica vaginalis; and, secondly, accomplishment of the adhesion of the walls of the sac by some surgical interference, resulting in its total or partial eradication.

The first of these methods was formerly more extensively practiced, and consisted in the application of collodion, tincture of iodine, or vesication externally to the scrotum, the use of leeches, of electricity, and the exhibition of digitalis or iodide of potassium internally. But, owing to the unsatisfactory results of these endeavors, surgical interference is the only principle which merits our attention.

The oldest method is that of puncturing the sac with the lancet, and should be unqualifiedly condemned. Any method which permits the fluid in the sac to escape into the loose cellular tissue underlying the skin of the scrotum is fraught with danger, owing to the tendency of the scrotal integument, when invaded by a traumatic œdema of this description, to become gangrenous. If not done antiseptically, moreover, this procedure most frequently leads to suppuration inside of the cavity, and may end in the destruction of the testicle.

The same objections hold good against the subcutaneous discision of the tunica vaginalis by means of a tenotome.

Acupuncture, electropuncture, and various other methods which flourished for a time, require no detailed mention here, as we have better and surer means at hand.

Simple puncture of the sac by means of a trocar under antiseptic precautions is only a palliative operation, and but rarely leads to a cure. It is indicated as a substitute for the operation to be immediately described in those cases only where the patient is in ill-health or infirm, and momentary relief is demanded.

Tapping, with consequent injection of some medicinal fluid into the sac, is an old method for curing hydrocele, and the most serviceable one for general use when carried out with all the modern improvements.

The fluids that have been used for such injections are many. Celsus is said to have used nitre, and others at different times have used sublimate, alcohol, wine, tincture of iodine, solutions of potassium iodide, of alum, of the sulphates of zinc, and of copper, of nitrate of silver, chloroform, ergotin, cold water, milk, hydrocele fluid, and many others, and even atmospheric air has been forced into the cavity. None of these have assured final success. Until comparatively recently the most favored of them has been iodine tincture, but on account of the violent and uncontrollable inflammatory reaction following the use of this drug, and the possibility of absorption to a dangerous degree, it has been largely superseded by pure carbolic acid. This method is known in this country as

*Levis's* method. This being at the same time the safest and most effective method, and the only one which can be unqualifiedly and unconditionally recommended, we give it, as follows:

The skin of the scrotum is first shaved on the anterior aspect, and cleansed with soap and water, alcohol, and some antiseptic solution; about five minims of a four-per-cent cocaine solution are now injected immediately beneath the epidermis, so that the point at which puncture is to be made is rendered anæsthetic. The patient being placed in the recumbent position, with the thighs somewhat separated, the operator grasps the tumor from its posterior aspect, with his left hand rendering the skin of the anterior aspect tense, and forcing the liquid as much as possible toward the cocainized point. A medium-sized disinfected trocar, with the cannula in place, is now grasped firmly with the right hand, the thumb being placed on the cannula, to within an inch of the point of the instrument. This serves to prevent the trocar from entering the tumor too deeply. The cannula is now firmly introduced with a slight rotary motion through the anæsthetized zone, well within the cavity. As it enters the sac it is well to depress the handle of the instrument slightly, so as to direct the point away from the testicle and epididymis. Care must be taken not to withdraw the cannula again after the sac is once punctured, otherwise the fluid forces its way into the loose areolar tissue surrounding the tunica vaginalis, and thus may lead to gangrene. The stylet being withdrawn, the entire quantity of fluid empties itself through the cannula, the left hand making gentle pressure from behind upon the sac the while.

A small syringe charged with pure carbolic acid is now fitted to the cannula, and about twenty minims of the acid injected inside of the sac. Before withdrawing the cannula it is well to apply some aseptic salve to the skin about the point of puncture, to prevent the outer skin from being burned by the acid, a drop of which may follow the withdrawal of the tube. The sac should now be manipulated so as to distribute the injected fluid over the entire inner surface of the tunica vaginalis. This is very important. The operation is entirely free from pain in almost all cases. In some instances slight nausea or faintness is experienced before the anæsthetic effects of the carbolic acid have developed. The scrotum is then enveloped in cotton, and judicious pressure maintained.

"The patient should be kept quiet on the day of the operation, but with proper suspension of the scrotum he may be allowed to move about after twenty-four hours.

"On the day following, and for about a week afterward, the tumor swells up as if it were refilling, and is solid or doughy to the feel. After this it begins to decrease until the sac is obliterated and a permanent cure is effected."

The trouble may recur again, however, at a later date, and in that case the operation may be repeated, a larger amount of carbolic acid being injected than before. This method may be adopted with propriety and excellent effect in the case of infants and young children. No cocaine need be used. A large-sized hypodermic needle serves for the trocar, and but one or two minims of carbolic acid should be injected.

The method known as *Volkmann's operation* consists in laying open the sac by a long incision under antiseptic precautions.

The patient having been anæsthetized and the scrotum and pubes shaved and properly cleansed, a longitudinal incision from two to four inches or more in length is made over the anterior aspect, and carried deeper until the sac is laid open to about the same extent. The fluid escapes. The edge of the parietal layer of the tunica vaginalis is now stitched to the edge of the wound in the skin by means of a good-sized catgut continuous suture. This makes an opening not unlike a buttonhole. The sac may now be irrigated with a 1-to-3,000 solution of sublimate, and two drainage-tubes are to be inserted into the sac, draining the lower and upper portions respectively. Iodoformized gauze may be used in addition to the tubes, being packed into the sac around them.

The dressing is done with sublimated gauze, laid on in sufficient quantity to absorb all secretions without necessitating a change for several days.

The penis should be well isolated from the dressings, so that they will not be soiled or infected during micturition. This may be achieved by passing the organ through openings of sufficient size in each successive layer of gauze applied to the scrotum. A sheet of protective tissue is finally added, adjusted in a manner to envelop the entire dressing and prevent contamination both by the fæces and the urine. The bandage is put on in a manner somewhat resembling a spica of both hips, but with additional turns, running from the pelvis of one side to the femur of the other, and crossing in the region of the perinæum. The patient is obliged to remain in bed for a period of two or three weeks after this operation.

The dressing is to be changed for the purpose of removing the drainage-tubes, or if the secretion moistens the edges of the dressing, so that decomposition of the secretions can take place, or if the temperature of the patient rises, indicating some retention or septic disturbance in the wound.

This latter operation (Volkmann's) is indicated in cases where the operation of injection of carbolic acid (Levis's method) has failed repeatedly. But it should not be forgotten that Volkmann's operation, if carried out with a strict attention to antiseptic details, may also fail and be followed by recurrence. In this case radical cure can only be attained by packing the cavity with iodoformized gauze, and leaving the latter *in situ* until suppuration ensues (ten days).

The operation is further indicated in cases where the sac walls are thickened to a great extent (periorchitis prolifera).

The only possible source of danger connected with this method, when it is antiseptically carried out, lies in insufficient drainage. Before antiseptic precautions were insisted upon (by Volkmann), extensive suppuration and pyæmia frequently followed the free opening of the sac.

The danger of retention is greatly averted by "button-holing" the incision.

More recently the excision of the sac of the hydrocele has been put forward as a radical cure, more especially in Germany. The method consists in making a longitudinal incision the entire length of the tumor, and then excising the serous membrane with the curved scissors and forceps, in a similar manner as is done with the synovial membrane of the joints. It is only necessary to remove the parietal layer of the tunica vaginalis, as the visceral portion in intimate connection with the testicle may be left untouched, and in fact is rarely affected by secondary changes. The operation should be done with the strictest antiseptic precautions.

We now turn to the description of the rarer forms and complications of hydrocele from a clinical point of view.

**Hydrocele Communicans** is an effusion in the tunica vaginalis propria testis which extends upward along the cord through the unobliterated processus vaginalis, and enters the peritoneal cavity. This form is always congenital, but it is comparatively rare.

There are other congenital forms of hydrocele, such as hydrocele proper (of the tunica vaginalis alone) and that of the cord, which are more frequent.

**Etiology.**—The etiology of hydrocele communicans is an embryonic inhibitory malformation, a failure of the vaginal process to become obliterated. The fluid in the sac in these cases is serum, and the same as is found between the coils of intestine in the abdominal cavity.

**Symptoms.**—The chief symptoms characteristic of hydrocele communicans is this, that, on compression of the tumor, the fluid disappears and the swelling becomes smaller. Considerable time may be required in order to displace all the fluid into the abdomen by pressure, especially when the opening leading into the peritoneal cavity is small. After the pressure has been removed the sac refills spontaneously, particularly when the parts are in a dependent position.

The shape of the tumor is more oblong or oval than that of hydrocele proper, and no limitation of the tumor below the inguinal canal can be made out.

In other cases, however, when the communicating canal is long and of very small caliber, there may be no difference in the shape and external aspect.

The other symptoms are the same as those of hydrocele proper—fluctuation, smoothness of surface, topic relation to the testicle, a normal state of the skin covering it, and translucency.

In the further course of bodily development, these congenital communicating hydroceles very frequently disappear spontaneously, probably in consequence of some traumatic inflammatory process; or they may lead to encysted forms of hydrocele, as that of the cord. In some cases, however, and especially when the communication is of a large caliber, they may persist, and have to be treated in the same manner as herniæ.

**Diagnosis.**—The diagnosis rests upon the possibility of emptying the tumor by manual pressure, and the symptom of its spontaneous decrease in size in the prone posture, and its increase in the erect one. Frequently a rippling sensation can be detected when pressure is made, caused by currents of the fluid at the abdominal opening, a sensation totally different from the murmur accompanying the return of coils of intestine during taxis.

**Prognosis.**—The prognosis in young infants is generally good, for the reason that in most cases cure is effected either spontaneously or by interference. In adults, or when the hydrocele communicans has persisted for a long time, spontaneous recovery is not to be expected, and surgical interference is indicated. If nothing is done, complications with hernia or the formation of encysted hydrocele of the cord must be expected.

**Treatment.**—The treatment of hydrocele communicans in the first days after birth is limited to judicious compression and cold applications. In cases where the trouble has persisted for some time and in adults, tapping or aspiration with a fine needle under antiseptic precautions is indicated, and subsequent compression of the neck of the sac by means of a truss or a *pelotte* and spica bandage. Tapping alone has frequently led to a permanent cure. Injections of irritants should be scrupulously avoided, as liable to set up inflammatory reaction in the peritoneal cavity.

**Hydrocele of the Spermatic Cord** may be either diffuse or encysted.

*Encysted hydrocele of the cord* (hydrocele funiculi saccata) is an accumulation of serous fluid in a closed sac, accompanying the spermatic cord, consisting of an unobliterated portion of the processus vaginalis peritonei. It is pathologically entirely comparable to hydrocele of the tunica vaginalis. The acute form of encysted hydrocele of the cord is not known to exist; it is always chronic. There may, however, occur acute inflammatory processes in a chronic hydrocele of this kind, and these attacks we designate by the term perispermatitis acuta. Such attacks may result from traumatisms of the encysted hydrocele of the cord, through infectious agents, irritating injections, etc.

The character of the effusion may be serous, fibrinous, or purulent.

These acute exacerbations occurring in chronic hydrocele of the cord are clinically important principally for the reason that they may be readily mistaken for recent hernial incarcerations.

The diagnosis can be made by determining whether the tumor extends through the inguinal canal, in which case we have to deal with hernia. By invaginating the loose skin of the scrotum on the little finger and pushing it up into the canal, the limitation of the tumor in hydrocele can be readily recognized. Percussion gives a tympanitic note in the latter case, and translucency is absent. Aspiration with a fine needle will decide in difficult cases.

The treatment of acute perispermatitis is identical with that of acute vaginal hydrocele.

*Chronic encysted hydrocele of the spermatic cord*, or hydrocele funiculi proper, is quite common in infancy, but somewhat rare in later life. In young children it is frequently associated with vaginal hydrocele.

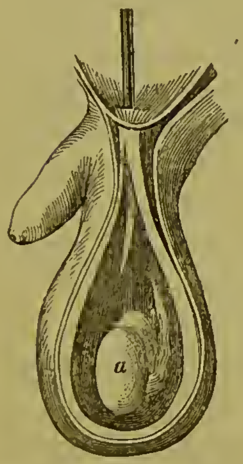

Fig. 2.—Hydrocele of the cord communicating with the tunica vaginalis testis. (After Linhart.)

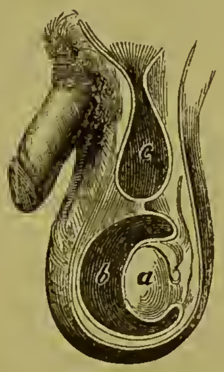

Fig. 3.—Hydrocele of the cord communicating with the peritoneal cavity. (After Linhart.)

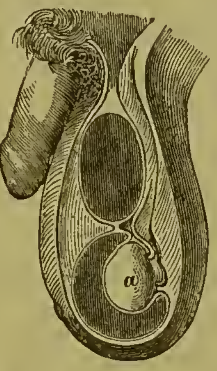

Fig. 4.—Encysted hydrocele of the cord. (After Linhart.)

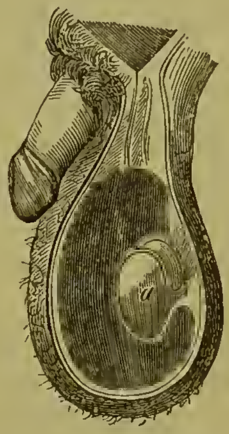

Fig. 5.—Hydrocele of the tunica vaginalis testis. (After Linhart.)

Any one part or the entire length of the abnormal serous sac accompanying the cord, from the peritoneal membrane down to the tunica vaginalis, may be affected, so that we may differentiate as to the site of the tumor between hydrocele funiculi intra-inguinalis, h. extra-inguinalis, or h. totalis. The situation below the external ring is the most frequent. The effusion may take place at one point only (hydrocele partialis simplex), or at several points independently (hydrocele partialis multiplex).

**Etiology.**—The etiology of chronic encysted hydrocele of the cord is little understood; its origin has been attributed to repeated injuries connected with developmental abnormities. The pathological conditions of hydrocele of the cord differ little from those of the tunica vaginalis. The sac consists of fibrous tissue lined with a serous membrane covered with tessellated epithelium.

The effusion into this sac also resembles that in chronic hydrocele proper. The quantity may be as much as two ounces. It is of a pale-yellow color, limpid, and contains much albumin.

Perispermatitis in rare cases may take on the conditions described under the heading Periorchitis, and we have consequently the various forms of hydrocele of the cord, characterized as perispermatitis prolifera, perispermatitis adhæsiva, perispermatitis hæmorrhagica, and perispermatitis suppurativa. For a more detailed description of these conditions, the reader is referred to the heading Periorchitis.

**Symptoms.**—The subjective disturbance caused by hydrocele of the cord is usually very slight, unless acute exacerbations in the growth of the tumor occur. In this latter case the patients may experience pain along the cord and show a rise of temperature.

The objective symptoms of hydrocele of the cord are the following:

Above the testicle and below the inguinal canal an oval tumor is to be seen and felt, which is hardly ever larger than a hen's egg, and which is covered by the normal skin of the scrotum, under which it is freely movable. The spermatic cord may be distinctly recognized immediately behind it, or situated internally to it. In rare cases the tumor may be found lying behind the cord.

Fluctuation is well marked, except in those cases where the sac is tense, owing to the presence of a comparatively large amount of fluid.

The tumor appears smooth to the touch, sharply defined, does not diminish on pressure or on change of posture, and is translucent, unless inflammatory changes have affected the walls.

Should suppuration ensue, the symptoms of acute abscess would supervene.

**Diagnosis.**—The diagnosis of hydrocele of the cord may be made when an oval tumor is recognized in the scrotum above the testicle, which is well defined above and below, is not painful on pressure, is movable under the skin, is soft and regular to the feel, although not fluctuating, and which is translucent. The testicle can be distinctly felt below it. The mobility may be so great as to permit of the entire tumor being pushed through the canal into the abdomen; but in such a case it can not be retained there, and appears as before when pressure is released. There is no impulse felt on coughing when uncomplicated with inguinal hernia. Hydrocele funiculi may also be mistaken for spermatocele or a retained testicle.

In difficult cases aspiration under aseptic conditions with a fine hypodermic needle will lead to a correct appreciation of the conditions present.

The prognosis is the same as that of hydrocele vaginalis.

**Treatment.**—The treatment of hydrocele of the cord in adults consists in tapping the tumor with a moderate-sized needle under antiseptic precautions, and the subsequent injection of from five to ten minims of pure carbolic acid. If this treatment should fail to effect a permanent cure after repeating it once or twice, recourse should be had to the more radical operation of laying open the sac and suturing the sac walls to the skin so as to form a fistula large enough to admit two drainage-tubes. Antiseptic dressings are now to be applied, and the patient kept in bed until the cavity of the sac has become obliterated.

In certain cases the extirpation of the walls of the sac may be done, or at least part of the walls may be excised. In any case the trouble may return, however.

In children aspiration alone generally effects a cure. If after this treatment the fluid should again accumulate, the injection of one minim of pure carbolic acid may be resorted to.

**Diffuse Hydrocele of the Cord.**—This condition stands in the same relation to encysted hydrocele of the cord as does hydrocele of the tunica communis to that of the tunica vaginalis.

The conditions present in diffuse hydrocele of the cord were experimentally demonstrated by Kocher. By tying a cannula into the tissue surrounding the cord at the point of its egress from the inguinal canal and forcing plastic matter downward along the cord, he produced a sausage-shaped tumor, which inclosed the cord on every side and extended downward as far as the testicle. This newly formed tumor displaces the testicle, causing it to lie horizontally, and parting it from the cord. The mass forms a bell-like covering for the testicle which can be felt below, lying in the concavity of the tumor. The epididymis lies between the testicle and the tumor. If the injection is increased, the tumor expands outward toward the skin of the scrotum, until it is nearly round in shape.

By injecting upward instead of downward the mass can be made to extend up through the inguinal canal, and a tumor is produced lying in the iliac fossa, situated in the subserous cellular tissue and resting upon the iliac muscle.

From this description it is apparent that the conditions present in diffuse hydrocele of the spermatic cord may be characterized as acute œdema surrounding the cord. It is limited by the fascia Cooperi.

This condition is rare. It is said to occur in adults after the thirtieth year, and it may be caused by the rupture of cysts situated near the cord, or secondarily after inflammation of the testicle by an interference in the return circulation in the spermatic vein, or by unknown means.

**Etiology.**—Probably the most frequent origin of the conditions described as diffuse hydrocele of the cord is to be found in the process of incapsulation and absorption of hæmorrhages in the regions surrounding the cord, caused by direct violence, or indeed by suddenly increased intra-abdominal pressure, resulting in the rupture of a vein. The hæmorrhages occurring after lesion of blood-vessels accompanying the funiculus spermaticus have the same anatomical location as the acute œdema described above, and hence when they become incapsulated, and serous fluid replaces the extravasation of blood, we encounter one or more cysts which correspond to the definition given above for diffuse hydrocele of the cord.

**Symptoms and Diagnosis.**—The symptoms of diffuse hydrocele of the cord much resemble those of an omental hernia; the tumor generally extends into the canal, the shape is pyriform, with the apex above; the surface is uneven or a little nodular to the touch; there is considerable resistance on pressure, and generally fluctuation in the lower portions. The size of the tumor decreases in the horizontal position of the patient, and increases again with the erect posture. The skin over the tumor appears normal.

In differentiation, however, the following facts must be brought out: The tumor can not be replaced inside of the abdominal cavity, but when pressure is made the fluid escapes into the subperitoneal or intermuscular tissues of the abdomen, and the tumor recurs as soon as such pressure is released. The configuration, in well-marked cases, is determinate, the bell-shaped formation surrounding the testicle from above being pathognomonic. Finally, diffuse hydrocele of the cord is translucent.

The *prognosis* of this condition should be guarded, on account of the liability of the affection to lead to gangrene of the parts affected through pressure.

The *treatment* of diffuse hydrocele of the cord varies with its *age.*

In the acute stage, incision under aseptic precautions is indicated; and in these cases special attention should be given to the tracing and checking of any hæmorrhage.

In chronic affections of the kind, aspiration with compression may be first undertaken, and if not successful, incision and drainage, or extirpation of the cyst walls, may be resorted to.

**Bilocular Hydrocele.**—This was first described by Dupuytren as *hydrocele en bissac*, and represents an hour-glass-shaped tumor, the lower portion of which corresponds to the distended tunica vaginalis, the upper portion to the greatly distended vaginal process of the peritonæum, not communicating with the peritoneal cavity, but obliterated at the point where the peritonæum is reached. Both these portions of the tumor connect by means of the narrow part, which is that portion of the vaginal process which lies in the inguinal canal. As the upper portion does not enter into the peritoneal cavity, and yet lies within the pelvis, it is necessary to describe its situation more precisely.

The upper sac lies in a subserous space close beneath the peritoneal membrane, and when it increases in size it dissects off the peritonæum and crowds it back.

In a hydrocele shaped in this manner the fluid can pass slowly from one enlargement of the sac to the other, through the narrow portion in the canal. When the patient therefore lies down, the scrotal tumor diminishes in size and the intra-abdominal one increases. This portion can be made out by bimanual palpation especially in narcosis, one finger being in the rectum. Pressure made here in the reclining posture will cause the scrotal portion of the tumor to enlarge.

This form of hydrocele is most frequent in adults ; it occurs, however, in children as well, but is rare. In some cases it has developed to an enormous size.

**Etiology.**—Etiologically the formation of bilocular hydrocele of this form is attributed to blows or other direct violence taking effect upon a hydrocele of the tunica vaginalis, and causing its sudden extension along the processus vaginalis upward into the abdomen.

Some writers view bilocular hydrocele simply as a diverticulum of the tunica vaginalis. And the term bilocular hydrocele is consequently applied to any diverticulum of the tunica vaginalis, irrespective of the fact whether this diverticulum extends upward into the abdominal cavity or in the scrotum, externally to the original sac, through the fibrous layer of the tunica communis. This latter class of cases may be termed hydrocele bilocularis vaginalis. The tunica vaginalis is believed to expand at the point of least resistance. In any case, however, the two sacs of hydrocele bilocularis intercommunicate, while so-called multilocular hydrocele consists of entirely separate compartments.

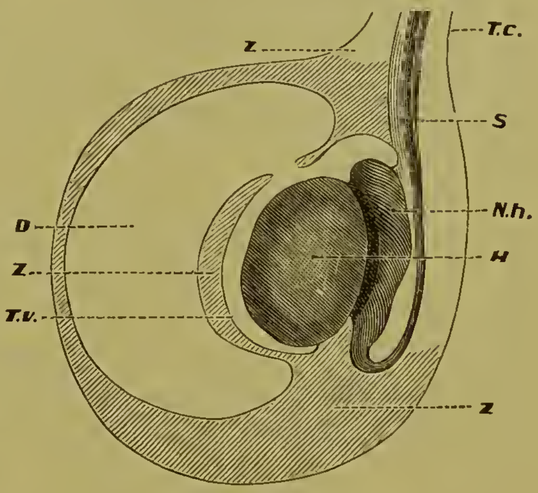

Fig. 6.—Bilocular hydrocele.

**Symptoms.**—The symptoms of hydrocele bilocularis much resemble those of simple hydrocele at first sight. But upon placing the patient in a recumbent position, and exerting pressure upon the swelling in the scrotum, the fluid gradually disappears, frequently (if the communicating opening is small) with a rippling sensation. As soon as pressure is released, however, the scrotal portion of the tumor refills; and in certain cases the abdominal portion of the tumor can be made out by palpation, combined, or in narcosis.

This expansion of the scrotal portion of the tumor also takes place when the patient coughs or exerts abdominal pressure.

The tumor is translucent, except in those cases where hæmorrhage has occurred after traumatisms, or where the sac is undergoing suppuration.

In other respects the symptoms are the same as in simple hydrocele, with the exception only as to the extent of the tumor.

The difference between diffuse hydrocele of the cord and bilocular abdominal hydrocele lies in the anatomical conditions. The fluid in both cases lies outside of the peritonæum. But in bilocular hydrocele this fluid is in an extension or diverticulum of the original processus vaginal peritonei, while in diffuse hydrocele of the cord, the fluid, when it has become encysted, lies externally to the vaginal process, and inclosed in a newly formed membrane, imbedded in the loose cellular tissue surrounding the cord.

The treatment is the same as that of simple hydrocele.

**Multilocular Hydrocele.**—This term is used to denote a multiplicity of cystic swellings accompanying the cord and extending from the tunica vaginalis toward the abdominal cavity, somewhat resembling a quantity of small hydroceles of the cord. This form is rare, and has been described by Kocher.

The pathology of this form is little understood.

The contents of these cystic tumors is not serous, as in true hydrocele of the cord, but watery or mucous. To the feel they present nodules, conglomerate, more or less tense, movable, transparent, and painless. The mass may extend through the inguinal canal and into the abdominal cavity.

The treatment is similar to that of simple hydrocele of the cord. Incision and extirpation will cure the most obstinate cases.

## COMPLICATIONS OF HYDROCELE.

Simple hydrocele may be complicated with hernia, with a hydrocele of the cord, or with both; with a communicating hydrocele of the cord, with or without a hernia; with hydatic cysts, and with other affections of the epididymis and testicle. Communicating hydrocele may be complicated by a hernia.

The most frequent complication of hydrocele is that with hernia. If the hernia is reducible, there is little difficulty in forming an accurate conception of the size and variety of the hydrocele. If, however, the hernia is incarcerated, or is an adherent omental hernia, the appreciation of the conditions is rendered more difficult.

The history of the patient must be duly considered. The want of well-defined limitation of the tumor above will lead the practitioner to suspect a complication.

Fluctuation is well marked in the lower portion, but not in the upper one, where in simple hydrocele it is most pronounced. The consistency varies in the upper and lower portion of the tumor. In hernia of the omentum the feel is doughy; while in incarcerated intestinal hernia the percussion note is tympanitic. Translucency is present only in the lower portion containing the hydrocele. Aspiration with a fine hypodermic needle will establish the presence of the hydrocele, and, after tapping, the nature of the complicating tumor can be more readily appreciated.

If hydrocele, hydrocele of the cord, and hernia are all present together, we find three tumors, which present symptoms differentiated in the same manner as that just described. The configuration and the touch enable us to determine the presence of the hydrocele of the cord between the two other portions of the tumor; it is tense, diaphanous, painless, dull on percussion, and not movable. The aspirating needle reveals serum.

In some cases, however, the conditions present in these complications are much more difficult to appreciate. The descending hernial sac may impinge upon an existing hydrocele, either of the tunica vaginalis or of the cord, in such a manner that it drives in one pole of the hydrocele sac and causes it to ingulf it. The hernial sac is then surrounded on one or all sides by the hydrocele sac. These forms have been described by A. Cooper as encysted hernia. If the hernia can not be reduced, the main reliance in the diagnosis must be placed in hypodermic aspiration.

A communicating hydrocele in children may contain a loop of intestine if the opening at the abdominal ring is large enough to admit it.

In all these cases the hernia is generally readily replaced, and the hydrocele can then be treated as indicated above.

Hydatic cysts and other complications of hydrocele arising from an affection of the epididymis or testicle can not well be diagnosticated as long as the hydrocele is present. It is difficult in the extreme to appreciate whether or not the testicle is normal when the hydrocele is well marked; and if the tumor is tense and large, it may be impossible to do more than determine the seat of the testicle. In all cases where suspicion of affections of the testicle and its adnexes is entertained, the hydrocele should be tapped or its sac laid open.

Hydatic cysts are most frequently overlooked, and are not found until radical operation for the hydrocele is done. They should then be extirpated. These cysts are generally pedunculated, situated at the upper portion of the testicle alongside of Morgagni's body, or replacing it, and of a size no larger than a cherry. If the cysts are of larger size, inversion of the testicle sometimes follows. Such cysts may burst spontaneously, and are believed by some to cause hydrocele.

Mention must be here made of a condition known as *hydrocele hernialis*, which is not, properly speaking, a hydrocele, but is described here for the sake of completeness.

This affection consists of a hernial sac, containing serous fluid identical with that of hydrocele, but not containing any coils of intestine or omentum or other abdominal organs.

The communication with the peritoneal cavity is generally maintained by means of a very small opening, which admits of our forcing the fluid into the abdomen; the tumor gradually refills, however, as soon as the patient assumes the erect posture and walks about.

These *hernial hydroceles* are not confined to the inguinal region and the scrotum alone, but occur wherever herniæ are met with, in the femoral and umbilical regions, and in the female as well—what is described as hydrocele in the female being a serous sac communicating through a small opening with the peritoneal cavity and lying in the canal of Nuck. In certain cases the opening communicating with the peritonæum may become obliterated. The tumor appears smooth and soft to the touch, fluctuating and translucent. It may generally be emptied by continuous pressure, but then it refills again. The testicle can be clearly defined beneath it, unless complications with hydrocele of the tunica vaginalis are present. The tumor, however, can not be defined above. The skin of the scrotum above the tumor is not affected. There is no pain on pressure, or it may be slight.

Hydrocele hernialis must be differentiated from omental incarcerated hernia, in which inflammatory exudation has taken place. In this latter case there is much pain, and complete reduction is not possible.

The treatment consists in extirpation of the sac, as for hernia.

**Differential Diagnosis of the Various Forms of Hydrocele and their Complications.**—Under the heading Diagnosis of Hydrocele the differentiation between hydrocele of the tunica vaginalis and other tumors of the scrotum was given. This differentiation applied only to such cases in which the limitation of the tumor in the scrotum was apparent.

If, now, by grasping the upper portion of the scrotum between the thumb and the forefinger we are able to feel that the tumor continues into the inguinal canal, we must next endeavor to determine whether the tumor is limited inside of the canal, or whether it extends into the abdominal cavity.

There are three varieties of tumor which extend into the abdominal cavity, and which may prove more difficult to differentiate—namely, hernia, hydrocele communicans, and bilocular hydrocele; for varicocele (which also extends into the abdominal cavity) is always easy of diagnosis, the peculiar feel, as of a number of earth-worms beneath the skin, the compressibility and the diminution of the tumor when the patient assumes the recumbent posture, being pathognomonic.

Malignant tumors extending upward from the testicle through the inguinal canal are also manifest by means of their size, the history of their commencement, the involvement of the integument of the scrotum, their feel, etc.

Hernia, hydrocele communicans, and bilocular hydrocele present a number of symptoms in common. They can be entirely or at least almost entirely reduced, they decrease in size in the recumbent position of the patient, and they show an impulse when the patient coughs.

Attempted taxis, however, generally discloses the nature of these tumors. The reduction of herniæ is accompanied by a peculiar murmur, a bubbling of air in the intestine, and takes place suddenly, while the fluid in the hydrocele communicans recedes slowly and continuously, sometimes accompanied by a flowing sensation; and the fluid in the bilocular hydrocele, when reduced, exhibits an elastic tension, and a tendency to return at once, nor can it be entirely reduced.

Moreover, a hernia shows tympanitic resonance on percussion, while hydrocele communicans and bilocularis both appear translucent.

Differentiation between hydrocele communicans and bilocularis (*en bissac*) can be made by ascertaining whether the fluid when evacuated by pressure from the scrotal portion of the tumor is forced into a sac situated extraperitoneally, in the iliac fossa, or whether the fluid is forced into the peritoneal cavity itself (hydrocele communicans). In the first case the sac can generally be felt by combined methods of palpation; pressure upon it causes the scrotal portion to refill, and thus establishes the diagnosis of bilocular hydrocele. This symptom also establishes the differentiation between an omental hernia and bilocular hydrocele.

Simple hydrocele of the tunica vaginalis with a diverticulum reaching into the inguinal canal, on the other hand, can not be emptied by pressure; and by pulling down the tumor the limitation inside of the canal can generally be determined. The little finger introduced into the inguinal canal, invaginating a portion of the scrotal integument, is of much assistance in establishing this point.

In hydrocele of the cord we have not only this limitation inside of the canal, but another limitation below, above the testicle.

Diffuse hydrocele of the cord can not always be differentiated from bilocular hydrocele (*en bissac*). The history of its commencement and its development from a hæmorrhage may permit of a probable diagnosis on account of the subcutaneous discoloration attendant upon the causative injury. The symptoms of both conditions are otherwise identical, but for the shape. Hydrocele bilocularis being pyriform, diffuse hydrocele of the cord is bell-shaped. The latter affection, however, is said to be so rare that little importance attaches to it.

The diagnosis of the nature of the fluid in various forms of hydrocele rests upon their translucency, a knowledge of the etiology and pathogenesis of the various forms, and the result of aspiration with a hypodermic needle.

The diagnosis of complications of the various forms of hydrocele may present considerable difficulties.

If simple vaginal hydrocele is complicated with simple hernia, we encounter two distinct tumors, the lower fluctuating, transparent; the upper one reducible, tympanitic. The hernia may be incarcerated, and contain no air (omentum); in this case the upper tumor is neither reducible nor tympanitic; but it is not translucent, and presents an unmistakable direct impulse on coughing.

In case hydrocele of the cord is present combined with hernia, we have the same symptoms present as before, with this exception, that the testicle can be readily felt and appreciated in hydrocele of the cord, while in simple hydrocele of the tunica vaginalis it is not easily felt, being enveloped in the liquid.

Encysted hernia can not always be differentiated from hernia with much fluid, unless the herniæ can be reduced. In this case a tumor giving the symptoms of simple hydrocele, or of hydrocele of the cord, remains in the scrotum after reduction.

A hydrocele hernialis can not be differentiated from a communicating hydrocele of the cord, except by the history; the latter affection occurring more frequently in children.

## SPERMATOCELE.

**Definition.**—Spermatocele is a cystic new growth containing spermatic elements situated between the testicle and the epididymis, near the head of the latter. It is comparatively rare.

**Etiology.**—As Kocher has shown experimentally, the vasa efferentia become dilated at their point of egress from the rete testis, and this is the most frequent origin of spermatocele. Dilatation of the efferent tubes at the point where they enter the head of the epididymis gives rise to the smaller subserous spermatic cysts frequently found in adults.

Rupture of a spermatic vessel by traumatism or disease (epididymitis) may also lead to spermatocele, if the extravasation becomes incapsulated. If hydrocele is present, communication may be established between the lumen of a spermatic duct and the cavity of the tunica vaginalis (hydro-spermatocele).

**Symptoms.**—In conformity with the etiological data just given, spermatocele then begins—not before the age of puberty—as a small tumor situated above the testicle, between it and the epididymis. It gradually but slowly increases in size, until it becomes as large as an apple. Some have been known to contain a quart of fluid. The growth takes place upward toward the inguinal canal, and the tumor becomes larger in circumference as it ascends. In this manner a pear-shaped tumor is formed, with the base above and the apex pointing downward to the testicle. At this point the testicle can always readily be made out, both poles and both sides being accessible for palpation. The epididymis can be felt behind the tumor, the testicle being situated in front.

**Diagnosis.**—These symptoms serve to differentiate spermatocele from hydrocele of the tunica vaginalis and from that of the cord. In the former the testicle is enveloped in the fluid, and can not be distinctly felt. In hydrocele of the cord the testicle is in close proximity to the epididymis, with the tumor above, while in spermatocele the tumor appears inserted between the testicle and the epididymis.

From other affections spermatocele can be differentiated by the fluctuation and by the translucency present, and in doubtful cases (such as when other cystic tumors of the parts are suspected) aseptic exploratory aspiration with a hypodermic needle must decide the diagnosis, the microscope revealing spermatozoa floating in the aqueous contents of the cyst when spermatocele is present. If the spermatocele develops from the testicle proper instead of, as is usual, from the efferent vessels, the growth takes place within the cavity of the tunica vaginalis instead of extravaginally, and in such cases spermatocele can be differentiated from hydrocele only by aspiration.

**Treatment.**—The cure of smaller spermatoceles may be attempted by extirpation, or incision and drainage ("Volkmann's operation") may be done under antiseptic precautions. In some cases tapping alone is said to have led to a permanent cure.

# VARICOCELE.

By EDWARD L. KEYES, M. D.

**Definition.**—Varicocele is an unnatural, varicose enlargement of the pampiniform plexus and the veins of the spermatic cord. What extent of turgescence of these veins must exist in order that their enlargement may be elevated to the condition of a morbid affection is a matter of personal estimate. A very mild form of varicocele—that is, a slight enlargement of these veins—is so common, that, when it exists upon the left side at least, it may be considered normal; and even an abnormal enlargement in its mildest form is so common that it is hardly worthy of the name of a disease.

**Frequency.**—Common estimate places slight varicocele at a figure of at least ten per cent of all adult males. It habitually is confined to the left side, but has been seen by all writers also occasionally upon the right side alone, and, when it is very marked upon the left side, the right side may be involved to a slight extent. Breschet operated only once on the right side in one hundred and twenty recorded cases. I have never operated on the right side, although I have seen the veins considerably enlarged upon this side perhaps half a dozen times.

**Etiology.**—In young men, shortly after adolescence, budding erotic fancies and imperfect sexual hygiene often lead to congestion of the testicle and over-distention of the veins of the cord, and when this is kept up too persistently, especially in subjects whose tissues are lax, or when the sexual faculties are taxed or teased, the foundation of varicocele is usually laid. The young bachelor is often unnecessarily alarmed by the presence of a cord slightly thicker upon one side than upon the other, especially if uneasy sensations exist in the testicle or groin, and he habitually distresses himself about this affection to an extent entirely disproportionate to its real significance. Commonly, marriage disperses both the slight turgescence of the cord and the unhappy fancies which have accompanied it; and Nature, by the aid of a well-regulated sexual life, disposes of the necessity for a surgeon. Old men rarely have varicocele, although the veins of their legs may be in a varicose condition, and the general tissues of their body more or less degenerated, and, when they do have it, it causes usually no symptoms, and they give it no attention.

It is entirely appropriate that this malady should be looked upon generally rather as a sexual neurotic derangement, so far as its symptoms are concerned, than as an organic disease. It is accused by young men, by widowers, by individuals who have committed sexual excess, by oxaluric and sexually neurasthenic patients, as the cause of many symptoms with which it has no possible connection. I have been appealed to in many instances to operate upon a slight varicocele, the existence of which as a physical fact was quite obvious, the call for the operation being based upon a desire to be strengthened sexually; to be relieved of morbid sensations in the testicle, the perinæum, the groin, the back, the bladder or elsewhere, with the idea on the part of the patient that, if these veins were done away with, all his morbid symptoms would disappear. Experience has taught me that it is not wise to approach these cases with any promise of permanent relief in any of the directions which I have indicated. Truly, if the enlarged veins are obliterated and a proper circulation restored to the testicle, its functions and its sensations are likely to be improved; but in very many instances the enlarged veins are only a single symptom in the general tableaux of the disease, and, although the veins may be mechanically thrown out of function, still the other symptoms may persist unless removed by appropriate means. This fact can not be too prominently paraded before the generally diseased mind of the young patient who seeks relief for this very moderate malady.

Yet, that varicocele does cause neuralgia of the testicle and dragging pain in the groin, and more or less functional disability in a sexual way, is entirely true, and the relief of the malady, when it exists to any considerable extent, is an entirely appropriate surgical procedure; and since it can be accomplished at the present day with so little distress and absolutely no risk or danger, what comfort it affords should not be denied the patient; but he must not be encouraged to expect a miracle as the result of a successful operation.

The left testicle, which is the common seat of varicocele, hangs habitually lower than the right. The larger veins only are furnished with valves, and on the left side the venous blood from the testicle empties into the left renal vein at a right angle, while upon the right side the blood flows at an acute angle into the ascending cava. This circumstance is believed to be the main predisposing cause of the more frequent occurrence of varicocele upon the left side. As an extra predisposing cause, the position of the sigmoid flexure of the colon on the left side, distended as it so often is in chronic constipation, must be noted. Yet, that the conditions upon the left side are more predisposing essentially to varicocele than on the right side, seems to be accentuated by the fact that in those cases of acute varicocele occurring after sudden effort, or sometimes after fatigue, local injury, or cold, or perhaps without obvious exciting cause, the left side is the one habitually involved. These cases of acute varicocele are usually only important from the fact that they give rise to very decided local symptoms of pain, distress, and tension, and occasion considerable alarm. I have seen a number of them, but under my observation they have all disappeared within a few days, being mastered by rest, local suspension, cooling lotions, a moderate anodyne, and a few laxatives; occasionally, slight permanent enlargement of the veins persists after an acute attack, but I have one individual in mind in whom the veins of the left cord were quite seriously enlarged by acute varicocele on two occasions, at an interval of several years, where mild treatment effected a positive and permanent cure, the veins returning absolutely to their normal condition.

**Symptoms.**—Leaving out the acute cases, whose consideration may terminate with the few remarks made above, varicocele usually comes on insidiously, and is discovered by accident, the patient's attention being attracted to the scrotum by some morbid sensations in this region, or a tired, dragged feeling in the groin and back, always worse after fatigue and prolonged standing. There may be an enormous varicocele with positively no symptoms whatsoever excepting the physical enlargement of the veins, while in other instances a very slight distention of the vessels seems to be the occasion of radiating pains up the groin, into the back, down the thigh, and more or less neuralgia of the testicle itself. These pains are aggravated by sexual excitement, especially if unrelieved, and by sexual excess; while in many instances they are temporarily relieved by the sexual act, but this relief is only of short duration.

In complete varicocele the vessels are elongated, their walls the seat of fatty atrophy, sometimes thickened, sometimes thinned; the valves broken down, the loops of veins within the scrotum feeling more like a bunch of earth-worms than anything else. Sometimes, when the veins are much degenerated, calcareous masses form in their walls, but this is exceedingly uncommon. In extreme cases, all the veins in and about the testicle and scrotum seem to be involved in the general varicose condition; even the veins between the tunica vaginalis and the tunica albuginea The scrotal veins are also enlarged. The scrotum itself becomes thin, the dartos atrophied, the texture of the scrotum so thin that the blue color of the blood in the veins becomes distinctly visible. In such extreme cases the integrity of the testicle itself is threatened in a physical way; the organ becomes reduced in size, soft, flabby, sensitive, and if the tone of the circulation be not improved by some operative measure, the function of the testicle necessarily becomes impaired and the organ itself goes on to partial atrophy. Yet, even in these extreme cases, the hypochondriacal and emotional side of the symptoms of the patient are often largely in excess of the actual physical signs of the disease.

**Diagnosis.**—Simple, uncomplicated varicocele can not well be mistaken for anything else. The wormy feel of the tortuous veins is entirely a physical symptom *sui generis.* When the varicocele becomes complicated by hydrocele, tumor of the cord, or any of the various forms of hernia, difficulties in diagnosis may arise, but in such cases varicocele sinks into secondary significance, the complicating disorder being the one calling for attention and requiring treatment. As this treatment, if applied surgically, involves a cutting operation and open inspection of the diseased area, the enlarged veins become a matter of very secondary importance, and are treated or not in connection with the main disorder, according to the inspiration of the surgeon at the moment of the operative act.

A simple test, in common, uncomplicated varicocele, establishes the diagnosis. The patient is made to lie down, whereupon the blood flows back into the abdominal cavity, and gentle pressure immediately removes the slight deformity. The surgeon's fingers are now placed with moderate firmness upon the external abdominal ring and the patient told to rise. Hernia will remain reduced; not so varicocele, unless the pressure at the external abdominal ring be so firm as to occlude the arteries as well as the veins. If the veins only are compressed, the varicocele repeats itself, refilling from below. Hydrocele can be diagnosticated by the usual simple method, or in any case of doubt by capillary aspiration.

**Treatment.**—In those very common cases in which the neurotic symptoms preponderate, they will require treatment more than the distended veins, and for such cases palliative measures, such as cold douches, the regulation of intestinal evacuations, and a snugly fitting suspensory bandage, are usually better means in the surgeon's hands than a radical operation, which, although it may relieve the physical disease, might fail to satisfactorily influence the morbid symptoms which the patient has ascribed to it. Varicocele never compromises health in any serious way, and ought not to be raised to the rank of a serious disorder, but frequently the patient's mind is so concentrated upon this obvious physical irregularity that a radical operation is justified. Formerly, such a radical operation was a rather serious matter. The open, cutting operation is, in my opinion, unnecessarily severe, nor does it save the patient from the possibility of damage. I have seen atrophy of the testicle follow the open operation for varicocele at the hands of one of the most competent surgeons in New York. It is never unavoidable. I consider it obsolete, and shall not describe it. Curtailing the scrotum is a method devoid of risk, which has been advocated in many quarters; but this also, unless the scrotum be very long and flabby, seems to me to be an operation unnecessarily severe, as it confines the patient habitually ten days or thereabouts to his bed, calls for the use of an anæsthetic, and is liable to all the ordinary complications of surgical wounds.

The operation which I advocate and habitually perform is simplicity itself. I described it first in 1886 (New York Medical Record, February 20 and September 18, 1886, and November 26, 1887). Recently a country schoolmaster, aged forty-five, came to me complaining of various sexual neurasthenic symptoms; and while examining him I recognized that there was a ligature about the veins of his cord, and that the vessels were obliterated. I called his attention to the fact, and asked him when he had had his varicocele operated on, and who had done it, remarking that the silk ligature was still in place, and that the operation had been well done. He informed me that he had seen my description of the operation, had sent to town and purchased the operating needle, and had operated upon himself, and he had no knowledge whatsoever of medicine or surgery of any sort. On the other hand, I have personally operated a second time upon patients who had had their veins tied up by surgeons by the subcutaneous method with silk, and yet upon whom the operation had failed, the failure having certainly been due only to the fact that the first knot of the ligature had not been tied with sufficient firmness and force.

In my opinion, no minor operation upon the genito-urinary tract is so simple and so efficacious as that for the relief of varicocele, unless possibly it be the treatment of simple hydrocele by capillary aspiration and capillary injection of pure carbolic acid, without knife and without cannula. This is very simple and thoroughly effective, although there are modern surgeons who, preferring to cut, still resort to the excision of the tunica vaginalis and the laying open of simple cases of hydrocele.

The operation which clearly meets the indications in all cases of varicocele, with or without pendulous scrotum, be the veins ever so enlarged, numerous, and tortuous, is the subcutaneous application of aseptic silk. If the operation be properly performed, every case, in my opinion, can be radically and permanently cured. I have never seen a patient detained in bed more than ten days, and this occurred only in my earlier cases, and in patients unnecessarily hyperæsthetic. Usually, five days is enough. There is no cutting, no loss of blood, very moderate pain. One of my patients, within forty-eight hours after the operation, traveled by rail without distress from New York city to the central part of the State. No accident has ever happened more serious than the puncture of a vein on one occasion, in which case there was considerable subcutaneous hæmorrhage, but it was all reabsorbed without treatment, and the final cure was permanent. In my first published operations with this method I advocated the use of catgut, but I soon abandoned this substance; it never cures. The catgut unties, or is absorbed too rapidly to effect the obliteration of the veins, and the varicocele always reproduces itself. After I adopted silk as a ligature my success became permanent. I have never produced abscess about the ligature, although in two or three instances there has been a slight oozing of sero-pus superficially discharging itself at the point of puncture; and in three instances that I can recall, in a hundred cases or more, the ligature has worked out at a period varying from three to nine months. In all the others the ligature has remained upon the veins, and I have felt it at the end of two years and longer as a firm little ferule of silk about the cord, the veins being obliterated beneath. My experience now covers very many cases, and extends over eight years or thereabouts, and I have no hesitation in recommending this method for application in the radical cure of any material case of varicocele sufficiently severe to call for any operative interference.

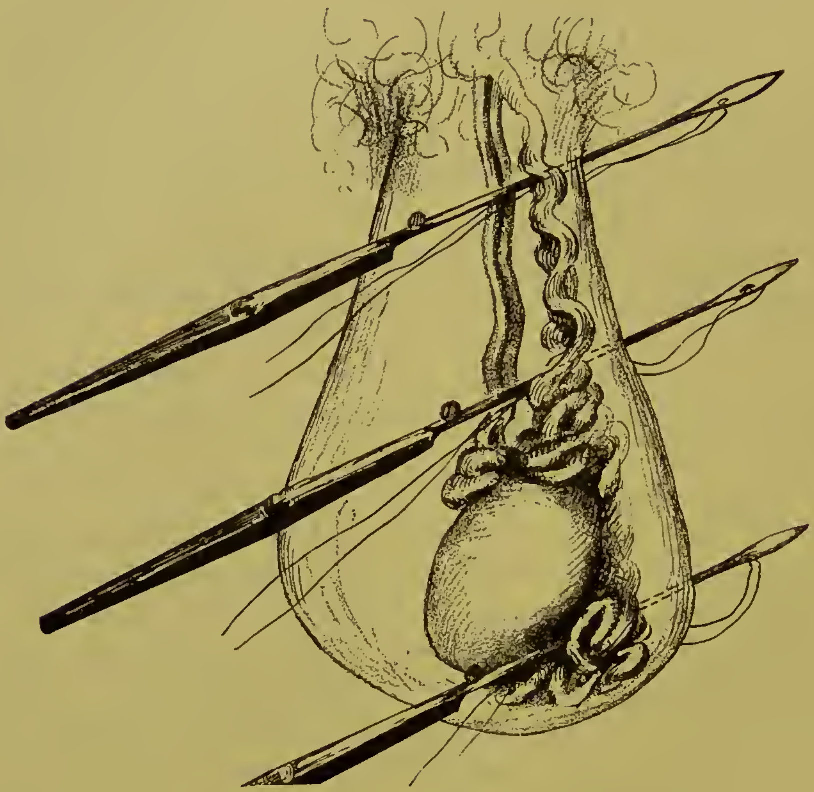

Fig. 1.

I have in several instances tied the entire cord, transfixing first on the outer side of the vas deferens and tying the cord between it and the outer side of the scrotum in one ligature, and then have transfixed on the inner side of the same vas deferens and tied up the rest of the cord in another ligature on the inner side tightly, and in spite of this apparent jugulation of the circulation of the cord no atrophy of the testicle has followed in any case. At present, my method is to apply three ligatures if the varicocele be severe, two if it be moderate, the third ligature being placed below the globus minor. The veins that hang down below the globus minor are not enlarged in a certain minority of cases, but in almost all instances of severe varicocele, this bunch of veins is quite a prominent feature in the malady, and it should not be neglected in applying the ligatures; the cut (Fig. 1) shows the position in which the three ligatures are habitually placed—one, reasonably high up upon the cord on the outer side; the second, close down to the globus major on the outer side of the cord; the third, below the testicle, beneath the globus minor. Occasionally, when one or more large veins can be felt running down the inner side of the vas deferens, they may be also included in a fourth ligature, but I personally have never applied more than three upon any one case. In very young people, where the testicle is not developed and the vas deferens is exceedingly small and hard to feel with the thumb and finger beneath the tegumentary covering, I have applied my upper ligatures subcutaneously, and then, making a simple linear incision below the testicle, have exposed the veins hanging beneath the globus minor and applied a silk ligature upon them under the guidance of the eye, washing out the wound properly and immediately closing it with catgut. Such a combination of the open with the subcutaneous method does not militate against a prompt recovery. I operated in April, 1892, upon a boy of eleven years by this method, and he came to my office for inspection, and asked permission to go and run in the country at the end of one week.

The subcutaneous ligature of varicocele by silver wire or silk over an outside spring or button, or by elastic ligature, these foreign substances being allowed to cut their way out, has been practiced for many years. I did one operation by this method and was so disappointed in it as a surgical method that I renounced it at once. Suppuration is inevitable with these substances, and the open method, is far preferable. Exactly when silk was first used subcutaneously and left in place I do not know. Ogston (Annals of Surgery, August, 1886) mentions that he used silk in 1878, and Barker (London Lancet, September 30, 1882, page 521) details two cases in which he employed silk, passing it through a puncture made with a knife. I do not know whether in these instances the silk suppurated out or not. I employed silk for the first time in the spring of 1886, after catgut had failed me, knowing that silk, properly prepared, was perfectly capable of remaining permanently among the tissues without producing irritation, and not knowing at the time that any one else had ever used it in this manner, nor do I now know that it has been so used before. Since that date I have relied exclusively upon silk, and I find that it leaves nothing to be desired. The Chinese twisted silk of largest size, so strong that it can not be broken in tying a single knot without the use of very extreme force, is the most suitable size and material, even for children. It is prepared by simply boiling it in ordinary water for twenty minutes, fishing it out of its boiling medium with a clean tenaculum, and dropping it, cut into proper lengths, into a wide-mouthed bottle containing simple ninety-per-cent alcohol. It keeps indefinitely, and is ready for use without further attention. The needle (a result of six different modifications and efforts in the same direction), upon which I now rely entirely, is a modification of the Reverdin straight needle. Fig. 2 shows the instrument. The eye is kept permanently closed by a spiral spring concealed in the handle, and the instrument is a closed needle for all intents and purposes, unless the button is pressed backward. By this pressure the eye at the front end of the needle is opened. Reverdin's needle has no such spring, and requires constant attention on the part of the operator to keep the eye closed.

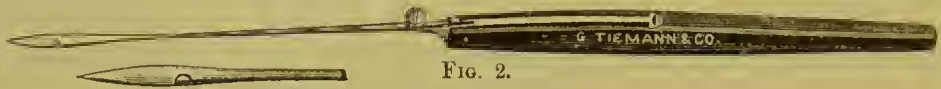

Fig. 2.

**The Operation.**—The patient should not take an anæsthetic. If he does so he must lie down, and in so doing the veins of the cord become empty and collapse, and some of them may escape, being inclosed in the ligature. If a patient be so sensitive that he insists upon the use of an anæsthetic, it may be given to him, provided the first and most important ligature be placed in its first position while he is in the erect posture; after this, with the needle *in situ*, he may be placed upon his back and an anæsthetic administered; because, after the first ligature is tied, the veins of the cord beneath become turgid and then they can be easily isolated, and the remaining ligatures placed under anæsthetic narcosis. Most patients prefer to have the entire operation done without the use of any anæsthetic. The pain of the puncture of the needle is very moderate, and although many patients faint perhaps to such an extent that they can not stand up, as they do in the case of many minor operations upon the genital apparatus, still it is a matter of no importance whether they faint or not, because, when two or three needles are placed in the first position, then the patient may lie down; and if he faints, it is all the better for him, because he is unconscious in that case of the only step in the operation which is really severely painful, namely, that in which the nerves of the cord are pinched in the first vigorous knotting of each ligature.

The patient stands upon a rubber cloth, well exposed to a strong light. The scrotum is thoroughly washed in a solution of the bichloride of mercury and water, 1 to 1,000. He should stand leaning against the side of the bed, so that the moment he becomes faint he may be placed upon his back, with his head low. He never does this until after the first puncture has been made, and this is the key to the entire operation. After this his fainting is unimportant. The distended veins are now separated by the thumb and finger of the left hand, grasping the scrotum from before backward, and the vas deferens, which may be easily distinguished by its whip-cord-like feel, separated from the package of veins and carried to the inner side. The Reverdin needle is now charged with a piece of silk fourteen inches long, and dipped into a solution of 1 to 2,000 bichloride of mercury, and the needle, so charged, with a vigorous thrust is made to transfix the scrotum from before backward, between the veins and the vas deferens, as high up upon the cord as it is convenient to operate. This needle is left in this its first position. Without delay the veins near the globus major are in a similar manner separated to the outer side of the vas deferens by the thumb and finger, which again grasp the scrotum from before backward, lower down than the first needle, and a second needle similarly charged with silk is with another vigorous thrust caused to transfix the compressed tissues and emerge posteriorly. This needle is also left hanging, and the thumb and finger pass beneath the testicle, and separate the veins that hang down below the globus minor, and between these veins and the globus minor the third needle is made to transfix the scrotum from before backward. This is the most difficult step in the whole operation, for here a vein may be pierced. By this time the patient is generally pretty faint. He is lifted up and placed upon a rubber cloth on the bed, flat upon his back. The punctures, the scrotum, the needles, and the silk are thoroughly irrigated with a 1-to-1,000 solution of bichloride of mercury, and, commencing at the upper needle, each ligature is placed about the veins in the following manner: With a tenaculum the loop of silk is seized posteriorly, and the button of the needle being pressed in the handle, its eye is opened and the loop of silk released. This loop is now pulled through posteriorly until its short end emerges, and then the position is that the scrotum is transfixed from before backward by a disengaged single thread of silk and an uncharged needle. The eye of the needle is now allowed to close, and the needle itself, by widening the scrotum, is pulled forward, but its point is not permitted to emerge at the anterior puncture, while the veins are all allowed to fall away into their natural, original position alongside the vas deferens. Then the point of the needle is again advanced under the dartos, and to the outer side of the veins, and cautiously brought up to the point of posterior puncture, out of which the strand of silk protrudes. Here care must be taken not by a diagonal puncture to include any considerable bit of dartos, or any cutaneous tissue, and not to transfix the silk, but the point of the needle must be brought out as accurately as possible exactly at the point of original posterior puncture, alongside of the silk.

The parts are again freely irrigated with bichloride solution, and the eye of the needle being opened by pressure of the button in the handle, the silk is inserted into the eye, enough slack being left upon the silk to allow the needle to be easily extracted, and by a sudden rapid motion the needle, recharged with the silk, is withdrawn through the anterior point of puncture. The same manœuvre is executed upon the other two needles, and after all the three silks have been thus placed, the scrotum is again thoroughly irrigated with the bichloride solution. The two strands of the upper silk are now to be grasped with one hand, and the scrotum, near the upper, posterior point of puncture, caught with the thumb and finger of the other hand, and, by a rapid and violent motion, any little piece of dartos caught in the posterior loop of silk is torn away, the tearing being distinctly appreciated by the fingers. Each loop of silk is treated in this manner. Now another irrigation, and then the few hairs growing about the points of puncture through which the loops protrude anteriorly are pulled away, so that they may not be included in the knot. Finally, a square knot is tied, the first motion of ligation being executed with very considerable force. The pain accompanying this first application of the knot is sometimes very intense. The completion of the knot, of course, causes no pain; and I habitually apply a third knot, so that I may cut my ends close and not fear that the knot may become untied. The two ends of silk are now cut off very close to the knot, and then, by pulling on the scrotum, after another irrigation, the knot disappears beneath the surface, and a subcutaneous silk ligature has been applied about the veins. Each of the knots is made in this manner; the points of puncture, if they bleed, dusted with iodoform or any suitable powder; the scrotum enveloped in dry cotton and supported by a T-bandage. A little anodyne, a slight laxative, and a mechanical support for the testicle, complete the treatment. Each point of ligation swells underneath the scrotum until it attains perhaps the size of a walnut—sometimes larger. The testicle itself swells, and becomes quite tense and moderately painful on the second day. By the fourth day the pain becomes very moderate, and usually on the fifth or sixth day the patient may apply a suspensory bandage, and go about without much discomfort. The inflammatory effusion about the ligature persists for several weeks, but slowly subsides without suppuration, leaving the silken ligature in place, where it may be felt as a painless cord about the obliterated veins for a very long period—exactly how long I do not know. I have felt it after two years. Of course, the entire success of this operation depends upon its aseptic performance.

**Ablation of the Scrotum.**—When the scrotum itself is so redundant and flabby that the surgeon thinks it ought to be removed, it may be taken away by pulling down whatever portion seems excessive, and clamping it with a Cooper or a Henry clamp on either side of the raphé, cutting off with the scissors the redundant material. Then the clamp is removed, the parts irrigated with a mild bichloride solution, all bleeding points scraped with the nail and ligated with catgut, and the cut edges on either side united with a continuous catgut suture, a small drainage-tube being inserted at the upper and lower angles of the wound. The dressing is according to the customary surgical methods, and union by first intention may be confidently expected if the operation has been performed in a cleanly manner. The patient should be kept in bed for about ten days, that union may become quite firm before he goes about.

# DISEASES OF THE SEMINAL VESICLES.

By PAUL THORNDIKE, M. D.,

Our knowledge of the vesiculæ seminales dates back to the early part of the sixteenth century, when we find the first descriptions of them. It was not, however, until toward the end of the seventeenth century that the first careful dissections were made and the first accurate descriptions of these organs written.

## ANATOMY.

The vesiculæ seminales are two irregularly convoluted tubes lying one on each side of the under surface of the male bladder and separated from the rectum by a layer of fascia (recto-vesical). They vary greatly in size in different persons, and even on different sides of the same person, but average perhaps two inches in length as they lie on the bladder. If dissected off and straightened out they are found to be two or three times this length. These tubes terminate posteriorly, near the points where the ureters enter the bladder, in blind pouches, and converge anteriorly, ending in ducts which open at the back of the prostate, each into the common ejaculatory duct of the same side. As they lie on the surface of the bladder, to which they are but loosely connected and from which they can be easily dissected, the posterior halves of them are covered by peritonæum. The vasa deferentia pass down from the internal abdominal rings to the base of the bladder along the inner sides of the two vesiculæ, and unite at an acute angle with the ducts of the seminal vesicles to form the common (ejaculatory) ducts. Just before this union takes place each vas deferens widens out into a tortuous sac or "ampulla" which closely resembles in structure the seminal vesicle itself.

The vesicles are made up of three coats—an outer fibrous covering derived from the recto-vesical fascia; a muscular coat having an external layer of longitudinal fibers; an inner circular layer; and a mucous membrane lined with columnar epithelium, and containing very small tubular glands.

The walls of the vas deferentia are thicker than those of the vesicles, and their canals are much smaller. Their structure is essentially the same, but the lining membrane does not contain so many glands.

The ejaculatory ducts pass upward and inward through the substance of the prostate to open into the prostatic sinus on each side of the verumontanum by small, slit-like openings.

The walls of the ducts grow thinner and their canals smaller as they approach their urethral termination.

The arteries of the vesiculæ seminales are branches of the middle hæmorrhoidal and inferior vesical, and the veins and lymphatics accompany them. The nerves help to form the hypogastric plexus.

Many curious anomalies of development of the seminal vesicles are recorded, and Guelliot gives a very complete account of them. He mentions nine cases where the two vesicles were not fully developed, two cases (both anorchids) where both vesicles were entirely wanting, and several cases where only one vesicle was present. In these last cases the corresponding testicle was normal, but the kidney was wanting, and the epididymis wholly or partly gone.

Two cases where the vesicles were fused into one are reported; but Guelliot thinks that both are open to question, as the dissections at the autopsies were not properly completed. Of 19 cases of anorchids collected by him, 12 had normal vesicles, while in the other 7 there was atrophy more or less marked, and in 6 the whole spermatic apparatus was wanting. Rott reports a case where the seminal vesicle was not connected with the vas deferens at all, but opened directly into the prostate, while the vas deferens opened into the ureter.

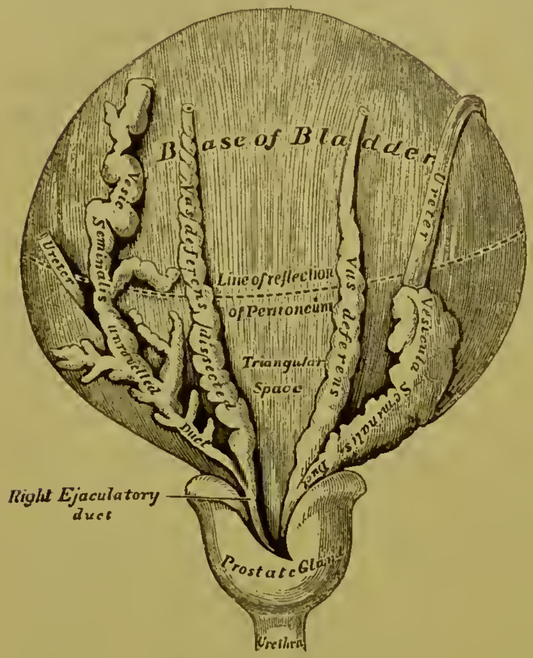

Fig. 1.—(From Gray.)

Weigert mentions an autopsy where the left ureter was found to empty directly into the left seminal vesicle.

The seminal fluid (semen) is a whitish fluid having a distinct odor of its own. It consists of a fluid vehicle (liquor seminis) which contains solid elements. This fluid is a clear, albuminous liquid, in which oil-globules and columnar epithelium may be seen. The solid elements of the semen are the spermatozoa and the seminal granules, the latter being small, round corpuscles always present in varying numbers, and of which further mention will be made.

## PHYSIOLOGY.

Of what use are the vesicles?

Ever since Fallopius wrote of these organs, nearly three hundred years ago, there has been endless discussion as to their function. Many writers have claimed that they are merely repositories for the spermatic fluid formed in the testes. Others say that they are something more than reservoirs—that they are secreting organs.

That the vesicles do secrete an albuminous fluid is undoubtedly true.

Their walls contain many albuminiparous glands, which secrete a fluid; and Guelliot mentions the case of a man without testicles, where the autopsy showed the vesicles to be full of such a fluid.

The fact that the vesicle does not atrophy after castration would seem to be additional evidence that it remains active in the absence of the testis. Atrophy does, however, occur in some cases after the removal of the testis, and Cruveilhier and Holmes both mention instances of such atrophy.

Carter thinks that the vesicular fluid serves as a vehicle for the testicular products. He says that at the time of ejaculation there is a vermicular action of the vas deferens and a contraction of the walls of the seminal vesicle, and that in this way the vesicular and testicular products are mixed together and poured into the urethra. This mingling of the two fluids is favored by the obliquity of union of the vas deferens and the duct of the vesicle.

That the vesicles are storehouses for their own secretions is true, but that they serve as receptacles for the semen formed in the testes is very doubtful. Kayser sums up the question very briefly and accurately. He had opportunities of examining the vesicular contents in seven cases after death, and found spermatozoa present in small but varying numbers in all cases. In concluding his thesis, he says that "the vesiculæ seminales are organs whose walls secrete an albuminous fluid; that they are receptacles for their own secretions, whose physiological importance is not yet known; that in the contents of the vesicles we generally find some spermatozoa—sometimes a very few, sometimes a larger number—but that they are not so numerous or constant that one may consider the vesicles as receptacles for spermatozoa."

## INJURIES.

The vesicles are so situated as to be very thoroughly protected from the effects of any external violence, and injuries to them, except as a result of surgical operations in their vicinity, are very rare, if not quite unknown.

**Lithotomy.**—It is well known that perineal lithotomy, especially in young boys, may be followed by sterility due to injury of the vesicles or the ejaculatory ducts. It is for this reason that these operations are becoming less and less popular with the surgeons of to-day. Teevan reports four cases where the lateral operation for stone was followed by sterility, no emission taking place during connection. He says that the operation involves laceration of the floor of the prostatic urethra, and a consequent obliteration of the ejaculatory ducts, whose orifices are so close together that even a lateral operation is apt to injure both. He advocates very free perineal incisions, arguing that the laceration of tissue by the removal of the stone is thereby reduced to a minimum, and the risk of sterility greatly diminished.

**Direct Violence.**—As instances of injury from direct violence in this region are so rare, it seems proper to mention three cases spoken of by Holmes, as reported by Mr. Hilton. In all these the vas deferens was probably ruptured. The symptoms were: 1. A feeling of "something giving way" in the groin at the time of the injury. 2. Immediate swelling of the testis of the injured side. 3. Urine drawn from the bladder with a catheter perfectly clear, but that which flowed from the urethra was full of blood. 4. Recovery from gradual atrophy of testis. Mr. Hilton thinks that in these cases the duct was torn across at a point between the internal abdominal ring and the place where the duct crosses the ureter. He mentions a case where at the autopsy he found an atrophied testis, and the vas deferens was torn across at the above point and the ends of it two inches apart.

**Fistulæ.**—Cases of pathological fistulæ involving the vesicles are almost never seen, but Lallemand mentions an instance where an abscess of the prostate involved the seminal vesicles and then broke into the rectum. The patient discharged his semen into the rectum at each connection, but at the end of two months a spontaneous cure took place.

## TUMORS.

**Malignant Disease.**—Although the seminal vesicles are sometimes invaded by a cancerous process which started in some neighboring organ (generally the prostate), instances of primary malignant disease of these organs are very rare. Guelliot collected fourteen cases where the vesicles were the seat of cancer. Of these cases, seven were secondary to disease in the prostate, three started in the bladder, one started in the testicle, one started in the rectum, one was primary, one not accounted for.

This last case, the only one of primary cancer of the seminal vesicles on record, was reported by Méricamp (see Guelliot's thesis), and the autopsy showed a cancerous mass in the left vesicle, with nodules in the peritonæum.

In May, 1891, Dr. G. W. Gay removed a seminal vesicle for malignant disease at the Boston City Hospital, and it is through his kindness that I am enabled to mention the case here.

The patient had suffered for several months with pain in the rectum and lower abdomen, had been troubled with constipation, and had lost considerable flesh and strength.

Rectal examination showed the prostate of normal size, or, if anything, rather smaller than normal, but the right seminal vesicle greatly enlarged, hard, with an irregular, roughened surface.

Under ether, an incision two inches long was made in the perinæum to the right of the median line and extending from the anus well forward to the scrotum. Careful dissection was made to the base of the bladder, and the growth was found to be not at all connected with the prostate, the latter being of normal size. The growth was firmly adherent, and could not be enucleated, but was removed as thoroughly as possible. A drainage-tube was left in the perineal wound. At the end of six weeks the wound was healed completely, but the symptoms were not much relieved. Since then the wound has broken open again, and now (November, 1891) there is a discharging sinus in the old scar, and rectal examination reveals a hard, finger-like mass in the situation of the right seminal vesicle. The microscope showed the growth to be of a cancerous nature, and as far as can be determined it was limited to the vesicle, and involved neither prostate nor bladder. The case is of especial interest, because (1) it was a case of cancer of the seminal vesicle (probably primary), and because (2) it is one of a very few cases where operation for the removal of a seminal vesicle has been attempted.

Guelliot believes that although so few cases of secondary cancer of the vesiculæ seminales are reported, the disease exists in many cases where it is not sought for or recognized, these organs being involved in many of the cases of a cancerous prostate.

**Sarcoma.**—Sarcomata of the seminal vesicles have been seen but once or twice. Zahn reports the only case of primary sarcoma of these organs. At the autopsy, which is most carefully detailed in his article, growths were also found in the kidney, heart, and mesentery; but Zahn believed the growth in the vesicle to be the primary one, because sarcomatous thrombi were found in the veins about the growth, and because no metastatic growth in the seminal vesical has ever been reported.

Coupland reports a case, with autopsy, of lympho-sarcoma of the prostate and seminal vesicles, with secondary nodules in the pancreas and suprarenal capsule.

**Cysts.**—Cysts of the vas deferens are occasionally seen, but cysts in the seminal vesicle have been noted but twice—by Ralfe and by Smith.

Ralfe's case was unilocular cyst of the left vesicle, and reached nearly to the umbilicus.

Smith's case was equally as large, and was thought at first to be a distended bladder. The diagnosis was finally made by getting a fluctuation wave between the finger in the rectum and touching the tumor and the other hand on the abdominal wall. This cyst was tapped through the rectum, and ten pints of fluid removed. A second tapping four weeks later resulted in a cure, as the cyst never refilled.

Several cases of hydatid cysts of the seminal vesicle were reported in the early part of this century by Lallemand and others, but their existence was by no means proved. Pinault, however, in 1826, reported a case of a large cyst between the bladder and rectum, which appeared to arise from the seminal vesicle to which it was attached.

## SPERMATIC COLIC.

In 1874 Reliquet described a disease which he called *colique spermatique*, and reported a case which had come under his observation. This disease is caused by an obstruction more or less complete of the ejaculatory duct. It is rarely met with, but is of considerable clinical importance, as an accurate diagnosis may be easily made, and the cure may be promptly effected.

**Symptoms.**—The trouble begins with a sharp, cutting pain in the perinæum at the end of each sexual connection, or, if the patient be living a continent life, from time to time with each erection. Defecation is also painful. The pain is very severe, and of a similar character to the pain of hepatic or renal colic. If the stoppage of the duct is complete, there is of course no ejaculation at the end of coitus. With these symptoms are generally associated those pointing to irritation of the neck of the bladder and prostatic urethra. There may be blood in the urine. The passage of a sound into the bladder shows great hyperæsthesia of the prostatic urethra, and a finger in the rectum feels one vesicle much larger than the other, with a smooth surface and very sensitive to the touch. Fluctuation may be felt; there may also be felt a bean-like prominence on the side of the prostate corresponding to the obstruction in the duct.

**Diagnosis.**—The diagnosis, then, is to be made (1) from the characteristic pain, (2) absence of ejaculation and (3) symptoms of prostatic irritation, together with (4) rectal examination and (5) the examination of the urine. The examination of the urine will generally reveal the presence of numbers of small, whitish masses (the sympexions of Robin), which have been the cause of the obstruction in the duct. In Reliquet's case large numbers of these masses were seen in the urine, and Robin described them as opaline, transparent bodies, two millimetres in diameter, with edges more or less beveled. They are the spermatic granules of normal semen held together in a mucous vehicle.

**Treatment.**—In Reliquet's case the passage of a sound into the bladder was enough to dislodge these masses, and in this way to bring about an accidental cure. In a second article Reliquet describes a similar case, which was cured by crushing the obstructing masses between a sound in the urethra and a finger in the rectum, exerting pressure on the affected side. Two such treatments completed the cure.

Guelliot mentions two autopsies where these masses were found in the vesicles, and Bergh mentions another case.

Besides these typical cases caused by obstruction to the ejaculatory duct by these concretions, there occur cases of the same type but of less severity where there is no such complete obstruction. Here the trouble occurs in men who are living a continent life, and is probably due to a slight obstruction of the duct from inflammation in the prostatic urethra, affecting the ejaculatory ducts to a greater or less degree by inflammatory extension. The vesicle becomes distended with fluid, and the patient complains of the same colicky pain during and after defecation, and to a greater degree with some erections and nocturnal emissions. Regular sexual intercourse invariably effects a cure. Guelliot mentions such a case, and the writer has known of two others.

While speaking of these concretions formed in the seminal vesicles, it should be mentioned that true calculi similar to those found in the prostate have been found in the vesicles of old men at autopsies. Guelliot mentions eight such cases. These calculi are composed chiefly of phosphate and carbonate of chalk, are not very uncommon, and are of no clinical importance, as they give rise to no symptoms which can lead to a diagnosis.

## INFLAMMATION.

Acute inflammation of the vesiculæ seminales (acute spermatocystitis) was recognized as a disease early in the present century, but Rapin's article (1859) gave us the first good description of it. The inflammatory process is the result of the direct extension of a posterior urethritis, and is therefore usually of gonorrhœal origin. That its existence is rarely demonstrated, is true; but it is undoubtedly often present where its existence is not suspected or looked for. Ricord says that in cases of gonorrhœal orchitis the seminal vesicle of the same side is almost invariably sensitive to the touch, and that inflammations of these organs would be much oftener found if oftener sought for. A mild form of the inflammation is doubtless the explanation of many of the cases of recurrent epididymitis and orchitis which are by no means uncommon; and the few autopsies which have been made upon patients who died during the course of an epididymitis confirm this idea.

**Etiology.**—The inflammation, then, starts in most cases from a posterior clap, but may result from the extension of a retro-strictural inflammation, from inflammation due to urinary infiltration, or from a tubercular prostatitis. Jordan Lloyd says: "I have seen the vesicle inflame secondarily to urethritis set up by the passage of a bougie, by the presence of stricture, and after coitus with a leucorrheal woman. I have seen both vesicles suppurate in one case where their inflammation appeared to be primary; at least, there was no antecedent cause discoverable in the urethra."

**Symptoms.**—The symptoms are very like those of an acute prostatitis, and the trouble is often confounded with prostatic inflammation. There are present the pain and feeling of fullness in the perinæum, the frequent and painful micturitions, the painful defecations and erections.

There is usually a great frequency of seminal emissions, the vesicle discharging its contents at short intervals, as does the urinary bladder when it is acutely inflamed. These emissions are very painful, and the semen contains a greater or less quantity of blood. Rectal examination shows a vesicle larger and more sensitive than normal, the normal vesicle being scarcely appreciable to the examining finger in the rectum. These symptoms are often followed in a few days by an epididymitis on the same side, and this sequela is pathognomonic when present.

**Diagnosis.**—The diagnosis, then, must be made from the general history of the case, which will show, as a rule, a posterior urethritis as the cause of the trouble; from the painful and frequent emissions, with perhaps more or less blood in the seminal discharges; from the rectal examination; and, finally, from the epididymitis which so often follows the symptoms pointing to vesicular trouble.

If, however, the disease is of a mild type, and the symptoms which should localize the trouble are not marked in severity, one must rely largely upon the rectal examination, which, together with the general history of the case, will be enough to establish a diagnosis.

The inflammation may run its course, and subside without occasioning further trouble; may become chronic, and manifest itself only by an occasional exacerbation; or may end in suppuration and abscess formation. The pus may point in the perinæum, or may break into the prostatic urethra, or even into the rectum.

The suppurating cases may result in a perivesiculitis, peritonitis and death, for it will be remembered that the vesicles are partially covered by peritonæum, and an inflammatory process in them may very readily extend to the peritoneal covering. Of such cases Gosselin reports one, Guyot one, Faucon one, Mitchell Henry one, Cock one, Velpeau one, Lloyd two, and Sebeaux one.

Purser speaks of a case where a purulent vesiculitis resulted in a general pyæmia, with abscesses in the heart, kidneys, bladder, etc.

**Treatment.**—The treatment of an inflamed vesicle should be palliative and symptomatic. Sitz-baths, poultices to the perinæum, with rest in bed and a bland diet, should always be enforced, and medication should be directed entirely to the relief of symptoms as they arise. If suppuration takes place, the pus should be evacuated as soon as found, either by puncture through the rectal wall, or preferably through a perineal incision, as recommended by Jordan Lloyd.

## TUBERCULOSIS.

It is beyond doubt the belief of the medical world of to-day that tuberculosis is a general disease which shows itself, as a rule, by settling down in one organ or another, and giving rise to symptoms which point directly to that organ. The infecting material is evidently carried through the system in the circulation, and the disease manifests itself by symptoms which indicate a definite localization of lesions.

Genito-urinary tuberculosis is relatively a masculine disease, although it occurs in women oftener than is commonly supposed. It usually makes its appearance in middle life, when the sexual organs are in their most vigorous and active condition. The disease is thought by many writers to invade this region either from the kidney downward or the testicle upward; but Réclus always declared that the testis was never the seat of primary tuberculosis, but that the prostate and seminal vesicles were invariably invaded before it.

That the disease always marches onward in a definite line, involving one part after another, is certainly not true, for a study of cases shows no such uniformity of invasion. In fifty-nine cases collected by Guelliot the disease occurred in the seminal vesicles in one third of the cases when there was no disease of the prostate discoverable, and there are many recorded autopsies which show tubercular disease of urethra, prostate, and seminal vesicles with no invasion of bladder or testis. In these cases the primary focus was probably prostatic.

That certain parts of the uro-genital system are especially prone to infection in persons who are predisposed to tubercular troubles, is undoubtedly due to the fact that these localities are most often prepared for the invasion of the tubercle bacillus by an inflammatory process of longer or shorter duration.

Tuberculosis of the seminal vesicles is almost never seen except as secondary to the disease in neighboring organs. That it does occasionally originate in the vesicle is true; and Solowcitschik reports a most interesting case, with the autopsy in which he thought the primary disease was undoubtedly vesicular.

At autopsies, tubercular disease of the vesicles is generally found in the form of caseous deposits which soften during life, and may break into the urethra, through the perinæum, or more rarely into the rectum. Occasionally one finds the walls of the vesicles studded with tubercular granulations, with little, if any, cheesy material.

In rare cases the patient may recover, the tubercular inflammation ending in a gradual fibrous degeneration and atrophy of the parts involved. More frequently, however, the softened products break through into the perinæum or prostatic urethra, forming sinuses which are constantly discharging.

**Symptoms.**—The invasion of the seminal vesicles by a tubercular process can be determined only by a rectal examination, combined with a general history of the case. The examining finger will find the affected vesicle larger and harder than the other; and, as the disease progresses, a tendency to soften will be noted at successive examinations before any fistulous traces are found.

Impotence and sterility almost always result in cases of long standing, but before these symptoms appear there is often a stage of great sexual excitability, with frequent seminal emissions, and a semen containing larger or smaller quantities of blood.

**Diagnosis.**—The general history of the case, the local symptoms, and the rectal examination will generally lead to a correct diagnosis, and a microscopic examination, showing tubercle bacilli in the semen, will confirm the diagnosis in some cases.

It must be remembered, however, that marked remissions, characterized by a subsidence of the local symptoms, and an improvement in the general condition of the patient are by no means uncommon in cases of tuberculosis in this region, and may prove very deceptive.

**Treatment.**—It should also be borne in mind that any instrumentation in cases of this kind is very apt to be followed by a marked increase in the severity of all the symptoms. This intolerance of any instrumental interference may give the surgeon his first suspicion as to the character of the disease with which he has to deal.

The treatment should, of course, be such as is followed out in tubercular disease of other organs. Change to a suitable climate, with proper care as to diet, fatty foods, etc., will accomplish a great deal in some cases. The question of operative interference in cases of genito-urinary tuberculosis with a hope of effecting a radical cure by the removal of the diseased areas is a very interesting one, but we are not yet in a position to advocate or condemn the procedure. The opinion of the conservative surgeons of to-day seems to be against any attempt of this sort. In a paper read before the American Association of Genito-Urinary Surgeons, in June, 1890, Dr. Bryson, of St. Louis, sums up this question as follows, basing his conclusions on a study of eighty-four cases and twenty-three operations. He says: "That all the evidence points to the conclusion that we have to deal, even in its earliest recognizable stages, with a general disease which manifests itself by localizations; that present experience does not warrant the belief that operations, however extensive, undertaken with the view of excising localized lesions, and thereby radically curing the disease, will be successful; that our chief resource is still in general antitubercular treatment, reserving surgical interference for the palliation and relief of pain, bleeding, and wasting suppuration."

The results obtained from the use of Koch's fluid in cases of genito-urinary tuberculosis have been for the most part either negative or distinctly unfavorable.

But one radical operation for the removal of a tubercular seminal vesicle has been recorded. Ullmann removed successfully the right seminal vesicle for tubercular disease, secondary to that in the epididymis. The patient was a boy of seventeen years, with a right-sided tubercular epididymitis of several months' standing. Rectal examination showed the right seminal vesicle twice too large and very hard, while the left vesicle was apparently normal. On June 17th the testicle was removed, and the vas deferens found pretty extensively infiltrated with tubercle; on July 27th the seminal vesicle was removed by Zuckerkandl's method. Ullmann describes the operation as follows: "A semicircular incision is made in the perinæum, with its base toward the sacrum. Then, with an assistant's

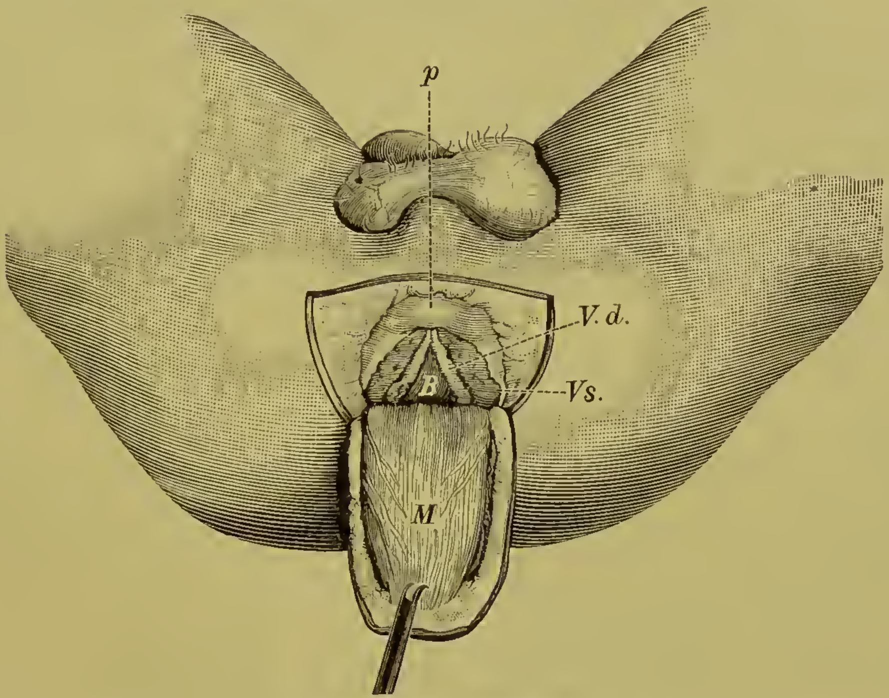

FIG. 2.—(From Zuckerkandl.)
*p*, prostate; *V. d.*, vas deferens; *V. s.*, seminal vesicle; *B*, bladder; *M*, rectum.

finger in the rectum as a guide, the parts are carefully dissected, the part of the levator ani which comes from the os pubis is divided and so the prostate is laid bare in the wound. Then the rectum is exposed a little more fully, and the base of the bladder brought more into prominence by means of a stone searcher introduced into it through the urethra. By this means the vasa deferentia and the seminal vesicles are brought well into view and may be dissected off.

"In Ullmann's case the right vesicle was found enlarged, cheesy at its upper part, and infiltrated below with tubercle. The vas deferens was also infiltrated. The left seminal vesicle was found somewhat enlarged and indurated. Both vesicles were therefore carefully dissected away, but the left vas deferens, which appeared healthy, was not removed. In the left upper corner of the prostate was a small abscess, and so this part of the prostate was also removed. The bleeding was readily controlled, a drainage-tube inserted, and the wound closed. There was some hæmorrhage that night, and so the wound was opened and plugged with iodoform gauze. During the convalescence some urine flowed through the wound, probably through the right ejaculatory duct, which was cut across with a knife during the operation. The convalescence was uninterrupted, and at the time the case was reported the patient was in excellent general condition, and the wound was all closed except one small fistula. Urine was passed entirely through the urethra, and the patient had had two erections since the operation. The microscopic examination verified the diagnosis of tuberculosis."

In commenting upon the operation, Ullmann says it should be performed—

1. In cases of primary tuberculosis of testis or epididymis at a time when no suspicious symptoms have appeared in the healthy side, but when the vesicle is involved on the diseased side. If both vesicles are involved, but one vas deferens is found healthy, the latter side should be left alone, both vesicles being removed.

2. In cases of primary tuberculosis of the seminal vesicle.

He says the resulting impotence should not militate against the operation, for in all reported cases of vesicular tuberculosis we find that impotence is sure to appear as a cardinal symptom of the disease.

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# FUNCTIONAL DISORDERS OF THE MALE SEXUAL ORGANS.

BY PRINCE A. MORROW, M. D.

UNDER the general class of functional disorders of the reproductive apparatus are comprehended the three affections which form the subject of this article: spermatorrhœa, impotence, and sterility. They are not, strictly speaking, functional diseases, as they may owe their origin to structural changes; nor do they always have a separate and independent existence, since they are oftentimes merely symptomatic of some local or constitutional state. Although they have many points in common in connection with their etiology, symptomatology, prognosis, and treatment, they are essentially distinct in their pathological import and significance.

Spermatorrhœa has reference to abnormal evacuations of the seminal fluid.

Impotence implies loss of virility or copulative power.

Sterility involves absence or pathological modifications of the semen.

All three morbid conditions may coexist in the same individual, or either may be present, independently of the others.

## I. SPERMATORRHŒA.

**Definition.**—Spermatorrhœa will be employed in this article as a generic term to denote all abnormal or pathological losses of the seminal fluid. As is well known, disorders of the genital function characterized by abnormal seminal losses exist in different forms and degrees of severity, and by most modern writers the application of the term spermatorrhœa has been restricted to those cases which represent the highest form, the superlative degree of seminal incontinence. While recognizing this distinction, it seems perfectly proper, since the greater includes the lesser, to group under a common heading different types of the same disorder.

**Classification.**—The several forms of seminal incontinence may be conveniently classified as follows:

1. Nocturnal pollutions. 2. Diurnal pollutions. 3. Spermatorrhœa, true and false.

**Nocturnal Pollutions.**—By nocturnal pollutions is understood a more or less frequent evacuation of the seminal fluid which takes place at night, ordinarily under the influence of erotic dreams, attended with erection and specific sensations. In more aggravated cases the emissions occur without erection, without pleasurable sensations or sufficient excitement to awaken the sleeper, who may have only a confused recollection, or, indeed, no knowledge of the accident except that furnished by visible traces of the discharge upon his linen.

**Diurnal Pollutions.**—This term is used to designate seminal losses occurring during the day without sufficient mechanical cause, as coitus or masturbation. Diurnal pollutions take place under the influence of various slight causes, mechanical or psychical, and are attended with full or feeble erection and diminished sensation.

**Spermatorrhœa.**—In its strictest acceptation this term is applicable only to those cases in which loss of the seminal fluid takes place without erection or sensation. The semen, instead of being discharged in a forcible jet by the reflex contraction of the ejaculatory apparatus, escapes in a purely passive manner, and oftentimes without the knowledge of the individual.

**False Spermatorrhœa.**—By this term is understood the discharge of a clear, viscid fluid from the meatus which does not contain spermatozoa, with or without erection or erotic excitement. It may appear at the meatus after straining at stool, the expulsion of the last drops of urine, or during exercise and certain movements. It is usually interpreted by the patient as an evidence that he is losing his seminal fluid, and not infrequently leads to a train of mental symptoms which are scarcely secondary in importance and gravity to those resulting from true seminal loss.

While the above division is convenient for purposes of description and study, it is evident that a strict line of demarcation can not always be established between the forms of seminal incontinence, since they represent different stages of the same morbid state, modified in degree according to the duration and progress of the case.

Between nocturnal and diurnal pollutions a clear line of distinction can be drawn, since the former always occur during sleep, while the latter take place when consciousness and volition are active; but between diurnal pollutions and spermatorrhœa the distinction is not always possible, since from temporary causes erection and orgasm may at one time be present, at another absent. When the stage of spermatorrhœa is fully developed, pollutions usually cease, but not always; they may continue to recur at intervals, sometimes the symptoms of pollutions, at other times those of spermatorrhœa, predominating. The only constant basis of differentiation between the two forms is the element of consciousness. *Un-*

*conscious* pollution would properly express the pathological condition present in spermatorrhœa.

Ultzmann, who classes all abnormal seminal losses under Motor Neuroses of the Sexual System, defines pollution as a neurosis of the sexual apparatus with spasm of the muscular coat of the seminal vesicles, and spermatorrhœa as a similar neurosis with paresis of the ejaculatory ducts.

**Pathological Significance.**—Recognizing that the mechanism of the production of seminal losses depends essentially upon a disordered innervation of the motor apparatus concerned in the evacuation of the seminal fluid, there remains for us to inquire into their pathological significance—In what degree are they to be considered unhealthy or abnormal? Here we shall find it extremely difficult to differentiate between the physiological and the pathological. Occasional aberrations in the mode of function of an organ are not necessarily pathological, since they may be neither the cause nor the consequence of disease. The mere fact of the occurrence of seminal evacuation without normal coitus does not necessarily establish it as a pathological phenomenon.

Every healthy adult male whose organs are in a state of physiological activity, especially if he leads a continent life, is liable to have nocturnal pollutions. Occurring within certain limits of frequency, attended with strong erections and pleasurable sensations, and followed by a sense of relief, such emissions are essentially physiological. They may be interpreted as the expression of a compensatory effort on the part of Nature to relieve the seminal plethora accumulated by the ceaseless activity of the seminiferous organs. Such occasional overflows of the seminal fluid, due to the overdistention of the seminal ducts and vessels, should be recognized as an indication of the normal functional activity of the organs, and in no sense harmful; their frequent repetition and their associated constitutional effects constitute the sole evidences of a diseased condition.

Certain authorities state broadly that when pollutions occur once in ten or fourteen days they may be looked upon as physiological; if they occur much oftener, they are pathological. The element of *frequency* alone can not, however, be accepted as a test of the physiological character of seminal emissions. It is difficult to generalize in a matter of this kind, or formulate a rule of universal application. Precisely as, in normal coitus, the frequency with which the act may be repeated within the limits of perfect health varies widely in different individuals, so also in the case of involuntary seminal emissions. The pathological influence of the absolute seminal loss is determined largely by the constitution of the individual: what might be excessive and harmful in one, may be supported by another with perfect impunity.

The *effect of seminal loss upon the individual* constitutes the surest test or measure of its normal or pathological character. Pollutions attended with that feeling which follows the gratification of a physical want, must be considered as healthful and sanative, irrespective of their frequency. On the other hand, when they are followed by languor, headache, backache, or other impairment of physical or mental vigor, they must be regarded as pathological, even though they occur quite infrequently and at long intervals.

Unfortunately, when nocturnal pollutions are fully established, under the influence of various causes, even from the force of habit alone, they have a tendency to become relatively more frequent, with the development of a train of mental and physical symptoms to be considered in connection with the symptomatology of seminal incontinence, and the patient passes from the boundaries of health into the confines of disease.

While it is impossible to draw a sharply defined line between normal and abnormal nocturnal pollutions, there can be no question concerning the pathological significance of diurnal pollutions. A healthy man may lose semen when asleep; a healthy man does not have an emission when awake, except as a result of coitus or some sufficient mechanical cause. Mere desire and venereal excitement, no matter how intense, are not sufficient in a state of health to provoke spontaneous ejaculation; there must be a peripheral impulse or excitation in the shape of mechanical friction. It may be positively affirmed that diurnal pollutions occurring during consciousness, when the will-power is active, except under the conditions just mentioned, always imply an abnormal excitability of the genital center or weakness of the motor apparatus, and are necessarily pathological.

As regards the pathological significance of seminal loss without erotic excitement, erection, or sensation, we must make a distinction between what may be regarded as a physiological accident and the symptom of a confirmed disease. The fact of a drop of semen appearing at the urethral orifice after defecation, especially after straining and the passage of a hard stool, is not of grave import. It is purely a mechanical phenomenon, due to the pressure of the hardened mass upon the seminal and prostatic ducts, and has no more significance than the milking of the seminal ducts for diagnostic purposes by the mechanical pressure of the finger introduced into the rectum. Men whose organs are in a perfectly healthy condition may have this experience. When, however, this seminal flow, instead of being an occasional accident, occurs habitually, with soft as well as hard fæces, without straining, and during the act of micturition, and is, in fact, more or less continuous, it constitutes the worst form of seminal incontinence.

**Etiology.**—Seminal incontinence has a most diverse etiology; many constitutional as well as local factors are concerned in its causation. In certain cases it is merely a symptom of some constitutional state, or the expression of a nervous disorder, which later may manifest itself in the graver forms of epilepsy or insanity. Myelitis or other lesions of the cord or brain are not infrequently attended with abnormal seminal losses. In view of the sympathetic lines which unite the genital and nervous systems, it is not surprising that functional disorders of the former occur in connection with a great variety of nerve lesions, both peripheral and central. The morbid tendencies may be excited into action by either direct or reflex irritation of the most diverse character.

Disturbances of the nutrition, resulting in various forms of nerve exhaustion, act as predisposing causes by weakening the capacity of resistance and deranging the equilibrium of the reflex centers. Seminal losses occur in the course of many acute and chronic diseases as a result of anæmia and nervous debility. The proximate cause may be purely local, as seen in the pollutions which occur as the result of an abnormal sensitiveness of the prostatic urethra, induced by gonorrhœal inflammation or other forms of local irritation. Many other local disorders of the genital and perigenital regions, presently to be referred to, act as predisposing or proximate causes.

An inherent weakness and irritability of the genital passages and of the nerves which control the motor apparatus may act as a powerful predisposing cause. The important *rôle* which heredity plays in determining disorders of the genital function has not been recognized or sufficiently emphasized by writers upon this subject. A parent may transmit a weak, irritable sexual organization to his offspring, just as weak eyes, feeble digestion, weak lungs, or other organic defects may be inherited. The genital systems of different individuals differ as much in their constitution and proneness to derangement of function as do the digestive and other systems. The motor neurosis, which in childhood is characterized by incontinence of urine, may continue to be manifest after puberty by seminal incontinence; as pointed out by Trousseau, one morbid condition may succeed to and replace the other.

Of especial interest in connection with the etiology of spermatorrhœa is the undoubted influence of heredity in creating a disposition or inclination to the practice of masturbation. Unquestionably the tendency to this habit, as to other vicious habits, may be transmitted from parent to offspring.

**Masturbation.**—First in point of importance, as well as of frequency, is the practice of masturbation, or rather self-abuse, since the means employed for the production of the venereal orgasm upon one's self are not always such as are implied in the strict etymological sense of the word masturbation, or friction by the hand.

The sweeping statement made by certain authors that all male human beings at some time practice masturbation, is no doubt an exaggeration of the truth. Yet it can not be doubted that a large proportion of young men begin their sexual life as masturbators. The pernicious and ruinous effects of this solitary vice, not only in the production of spermatorrhœa but other functional disorders of the genital system, have been painted in the most lurid colors by ignorant pretenders who cultivate this field of quackery. On the other hand, the evil effects of "solitary pleasures" have been glossed over or minimized by text-book authorities, who claim that the seminal loss from masturbation is no more injurious than that of normal coitus. Sir James Paget asserts that the injurious effects of masturbation have been exaggerated, and that seminal loss through this practice entails no more ill effects upon the constitution than that through normal coitus exercised with the same frequency.

*A priori*, it might be assumed from analogies in the mechanism of masturbation and coitus, both involving a mechanical cause, that their effect upon the individual would be identical. This, however, is by no means the case; the nervous exhaustion and other reactionary effects upon the general system which follow the unnatural act are much more pronounced. In addition, there are other circumstances or conditions ordinarily connected with the practice of masturbation which have a tendency to aggravate or intensify its harmful effects.

In the first place, the habit is usually formed at an early age, often before puberty, when the sexual organs are immature and undeveloped, and entirely unfitted for this demand upon their functional activity. The injurious effects of this precocious and excessive use of rudimentary organs are oftentimes manifest in arrest of development, a retarded and stunted growth, so that long after the period of puberty the external genitals present an aspect of infantilism. Most masturbators who have begun the practice early and carried it to excess, have small and undersized organs. The effect of this early excess upon the composition of the semen and the functional vigor will be considered in connection with impotence and sterility.

In the next place, the very nature of the habit and the facility of its performance render its indulgence inordinately frequent—vastly more frequent than is possible with coitus, where not only consentment and co-operation of another party, but favoring time and opportunity, are requisite. To the devotee of this solitary vice the external factor as well as the opportunity are always present; there being no hindrance, no bounds are set to the indulgence. The first effect of this repeated indulgence remarked by the patient is a precipitation of the ejaculation, which he is apt to regard as an evidence of increased vigor, but which, rightly interpreted, is due to the congestion of the prostatic mucous membrane and an irritability of the reflex centers, so that abnormally slight causes are sufficient to bring about the spasmodic contraction of the seminal vesicles and ejaculatory ducts. When this pathological condition is established, involuntary emissions begin to appear, and continue with progressive frequency, it may be, long after the habit which occasioned them has been abandoned.

**Sexual Excess.**—After masturbation, sexual excess ranks as the most common cause of spermatorrhœa. The exercise of the sexual organs within certain bounds undoubtedly has the effect of strengthening, invigorating, and preserving them in their full integrity; their excessive exercise or abuse, on the contrary, engenders disorders of function, oftentimes associated with pathological changes in the organs involved. No absolute or even approximate rule can be formulated with regard to the frequency with which the sexual function may be exercised within physiological limits. A frequency of repetition which might constitute sexual excess in one individual may come within the physiological capacity of another more strongly sexed. The effect upon the system must be accepted as the sole test of its normal or abnormal character.

Since, as before premised, most men are initiated into sexual life by masturbation, the injurious effects of which continue to be manifest long after the habit has been relinquished, it is evident that in appreciating the pathological results which follow natural sexual excess the morbid impulse communicated by the former practice must act as a strong coefficient. Indeed, it is often impossible to disassociate these two pathogenic factors which determine analogous if not identical effects.

It is still a question whether the harmful result of sexual excess is due to the absolute loss of a highly elaborated "vital" fluid, or whether it is to be attributed to the intense nervous excitement engendered by the orgasm. If the seminal fluid ejaculated has been stored up in the seminal vesicles, and therefore stands in the relation of an excreted product to the general system, its mere evacuation should be a matter of slight or indifferent import. On the other hand, if the injurious effect of sexual excess were due solely to the explosion of nerve force attending ejaculation, women, in whom this excitement of the nervous system may be quite as intense, should also suffer bad effects. It is well known, however, that women may experience the "cynic spasm" in frequently repeated coitus without any sense of exhaustion. Then, again, in the advanced stage of spermatorrhœa, escape of the semen takes place without any nervous excitement, or, indeed, apparently without the active participation of the nervous system. In this class of cases it is fair to assume that the constant spermatic drain causes exhaustion of the nerve-centers, just as the saccharine drain of diabetes impairs the nutrition of the general system.

Sexual excess, whether by natural or unnatural practices, determines an irritable weakness of the genital organs. As a result of the frequently repeated erections and abnormal stimulation of the genital canals there are induced a hyperæmia and hyperæsthesia of the mucous membrane of the prostatic urethra. This constant congestion causes a chronic or subacute inflammation of the pars prostatica, analogous to the catarrhal inflammations of other mucosæ from long-continued irritation. The introduction of a sound shows the urethra to be inflamed and sensitive. The urine is often found loaded with shreds consisting of pus-corpuscles, epithelium, and occasional spermatozoa. Under endoscopic examination the mucous membrane appears swollen, reddened, and partly deprived of epithelium. The ejaculatory ducts also participate in these morbid changes; their walls become enlarged and relaxed and their orifices patulous, permitting a ready escape of their contents.

Associated with these morbid changes in the motor apparatus there is engendered, by frequently repeated stimulus, an irritable condition of the efferent nerves which convey sensations to the ejaculation center, conjoined with an abnormal excitability of the reflex cerebral and spinal genital centers, as a consequence of which the impulse to reflex discharge is set in motion by abnormally slight causes, hence pollutions and premature ejaculations.

**Continence.**—The etiological significance of continence in relation to abnormal seminal losses is differently appreciated by different authors. The impulse of the genital organs to act is a law of Nature, and is expressed in physiological pollutions. In persons of nervous, excitable temperament, especially when the sexual instinct is stimulated and kept in unnatural excitement by lascivious thoughts and external impressions, pollutions not infrequently surpass the physiological limit and become pathological; a condition of mental masturbation is thus established. Many young men who lead continent lives and yet have involuntary emissions become possessed, from reading quack literature, of the most extravagant sexual ideas. They see in every emission an evidence of loss of virility. The constant concentration of mind upon the genital function, and the exaggerated fear of having pollutions, constitute a most efficient cause of their production. Sexual hypochondriasis is more frequently the cause than the effect of pollutions.

Continence as a provocative to masturbation may be considered indirectly a cause of abnormal seminal losses. Young men of virtuous instincts and studious tastes, theological students and others, often drift into the practice of masturbation, imagining that they preserve their purity while indulging in this vicious habit.

**Local Causes.**—Since abnormal seminal losses originate in congestive or inflammatory changes in the prostatic mucous membrane and ejaculatory ducts, it is evident that any condition which determines an irritation of this region will contribute to their production.

Phimosis may prove a source of reflex irritation from the pressure of a tight foreskin or the presence of retained smegma. Balano-posthitis, herpes, vegetations, etc., may also cause pollutions in persons predisposed thereto.

Various lesions of the urethral canal act as exciting causes. Gonorrhœal inflammation especially plays an important *rôle* in the genesis of pollutions, especially when it has penetrated the deep urethra. The inflammation creates a condition of increased irritability, by which spasmodic action of the expulsive apparatus is more readily excited. The common occurrence of pollutions in the course of urethritis, especially when complicated with posterior urethritis, prostatitis, epididymitis, inflammation of the vasa deferentia, etc., is constantly referred to in the article on Urethritis. Acute prostatitis, or a chronic inflammatory state of the neck of the bladder from any cause, favors pollutions by inducing a morbid irritability of the prostatic ducts.

Stricture of the urethra at any point of the canal may be a cause of pollutions. The irritation may be set up by the pressure of decomposed urine retained behind the stricture. Congenital narrowing of the meatus, as well as spasmodic stricture, may act as exciting causes.

Inflammation of the seminal vesicles produces pollutions; in acute spermatocystitis the seminal discharge is usually painful, and mixed with blood and pus.

Contusions of the perinæum, followed by acute inflammation, may determine pollutions. Abnormal states of the rectum and anus, as hæmorrhoids, ascarides, eczema, fissures, pruritus, may cause sympathetic contractions of the seminal vesicles and expulsion of their contents. Any coincident inflammation of the pelvic organs attended with disorders of the nerves of that region may react upon the nerves of the genitalia and provoke pollutions.

**Symptomatology.**—The symptoms of spermatorrhœa are as diverse as are the causes which produce them; they vary according to the form of the disorder, its degree of development, and the constitutional peculiarities of the individual.

**Course.**—Spermatorrhœa is by no means typical in its course and mode of evolution. In the ordinary evolution of a spermatorrhœa which owes its origin to masturbation the beginning of the trouble is marked by the occurrence of nocturnal pollutions; these may be succeeded by diurnal emissions, and finally the loss of seminal fluid takes place without erection or any form of erotic excitement. At first the nocturnal pollutions occur at comparatively rare intervals, and are attended with erection and normal sensation. After a time they are reproduced more frequently, until they may occur several times a week, or even more than once the same night. With this increased frequency of repetition there is a progressive enfeeblement of erection, and emission takes place from a flaccid organ without sufficient sensation to arouse consciousness; the individual awakes and finds himself polluted. The normal sensation peculiar to the discharge of semen is not infrequently replaced by a disagreeable sense of heat and burning in the urethra.

When the disorder is more fully developed, involuntary emissions occur when the patient is awake. In an early stage the ejaculation may be attended with strong erections and specific sensations; in a more advanced stage it occurs with partial or incomplete erection, even when the organ is limp and flaccid, and is attended with perverted sensation.

A variety of slight causes may determine ejaculation. Any peripheral irritation, as friction of the glans from movements of the body, riding on horseback, or any slight mechanical irritation of the genital organs, may be sufficient to provoke it, or the impulse may come from a remote organ. Shampooing, shaving, or simply brushing the hair have been known to occasion an emission.

Purely psychical impulses, such as the desire excited by the presence or contact with women, the sight of obscene pictures, lascivious thoughts, the lewd images created by the imagination, may be sufficient to discharge the reflex act of ejaculation. In a more advanced stage, which marks the development of true spermatorrhœa, the loss of semen takes place without erection, sensation, or even without sexual thought or desire. While this loss is more apt to occur during the act of defecation or micturition, there may be an almost continuous escape of seminal fluid.

It is by no means to be assumed that the clinical history of all patients affected with abnormal seminal losses exhibits this progressive course; in the vast majority it ends with the stage of nocturnal pollutions, in a small minority it passes to the stage of diurnal pollutions, while in comparatively few does it culminate in true spermatorrhœa.

The pathological effects of abnormal seminal losses are ordinarily manifest in local inflammatory changes, and, secondarily, in affections of the nervous system or disturbances of the general nutrition.

**Local Effects.**—The local changes expressed in irritable weakness and derangement of the motor expulsive apparatus, and which are closely related to impotence, have already been referred to. No less significant are the changes in the character of the seminal fluid, which have an important bearing upon the production of sterility. As a result of the abnormal demand upon the secretory activity of the generative organs, the composition of the semen undergoes marked modifications. While the quantity may not be materially diminished, the quality is deteriorated. It becomes thinner in consistence, more watery, and less opaline, resembling lymph. The spermatozoa may be diminished in number, altered in quality, or entirely absent. They are small, immature, malformed, often motionless, and feebly charged or entirely deficient in fecundating power.

The condition of the external genitals presents nothing absolutely characteristic. As a rule the organs are smaller, with less appearance of vigor. Many writers have spoken of the hardness of the corpora cavernosa as pathognomonic, but this is by no means a constant condition. The skin of the penis and the testicles is less sensitive to electrical stimulation; the urethra is hyperæsthetic, especially the pars prostatica, which explains the burning sensation often attending the emission of semen. In a more advanced stage of the malady, there is, coincident with a decline of the inflammatory condition, a gradual decrease of this disagreeable sensation in the prostatic and perineal region.

**Constitutional Effects.**—The pathological effects of abnormal seminal losses upon the general system present the greatest variations. The immediate effects of pollutions are certain subjective sensations—a sense of *malaise*, great fatigue, headache, backache, mental dullness, etc. In the early stage these sensations are ordinarily of short duration, and may entirely disappear in the intervals between the emissions.

The more profound disturbances of the general health of the individual which make up the clinical picture of spermatorrhœa depend largely upon constitutional peculiarities. In many cases the signs of the disorder are localized in the genital apparatus, the pollutions constitute the whole disease, while the general health is comparatively unaffected; in other cases emissions occur but rarely, and the entire train of morbid symptoms is expressed in nervous and nutritive disorders. Paradoxical as it may appear, the strongest and most robust individuals are often those in whom the local disturbances are the most severe. The etiological explanation is that their stronger physical organization permits of greater abuse, while in persons of feebler endowment the system remonstrates by symptoms that can not be disregarded before the abuse is carried to such harmful excess.

In an advanced stage of the malady the *motor* and *sensory* disturbances are more generalized. A condition of nervous irritability supervenes; the patient is restless, can not sit still or remain long in any position. This disposition to move, notwithstanding muscular fatigue, has been pointed out as pathognomonic by various observers. In more aggravated cases involuntary twitchings, trembling of the hands and limbs, and other choreic symptoms are developed; the gait is unsteady and vacillating.

Sensory disorders are also well marked. The subjective sensations which immediately follow pollutions become more constant. The patient is subject to various neuralgic pains which are exceedingly capricious, hyperæsthesia of one part succeeded by numbness, formication, hot and cold flashes, extremities cold and clammy, sensations of heat and heaviness in the occiput, tenderness of the scalp; in fine, a group of symptoms which are now recognized as characteristic of neurasthenia, and pointing to exhaustion of the brain and spinal cord.

The effects of abnormal seminal losses upon the higher intellectual centers are most characteristic; the essential mental faculties are weakened. The patient finds that his perceptive powers are less acute; he can not concentrate his mind upon any subject, and is therefore entirely incapacitated for intense or prolonged mental exertion. His memory is impaired, especially his memory for words; he constantly pauses in his speech for loss of a word, and his articulation becomes halting and stammering.

Mental disturbances are also manifest in the attitude and behavior. A morbid self-consciousness is almost pathognomonic of spermatorrhœa. The patient shuns society, likes to be alone, continually broods over his sexual trouble, imagines himself impotent, and that his humiliating secret may be read in his face; his glance is furtive; he rarely looks one straight in the eye. As a result of this morbid self-concentration, a fixed melancholy seizes upon him; this condition of sexual hypochondriasis is most deplorable, and forms the darkest shades in the clinical picture of spermatorrhœa.

A tendency to tabes, epilepsy, insanity, or other grave nervous disorders is not infrequently developed into active existence by the neuropathic influence of spermatorrhœa.

In addition to these purely nervous phenomena, disturbances of the general nutrition are seen in various disorders of the digestive, circulatory, and respiratory systems. Dyspeptic symptoms are common in the course of spermatorrhœa, characterized by inappetence, disgust for certain articles of food, acid eructations, epigastric cramps, intestinal pains, constipation, and sometimes by marked emaciation. The palpitation, oppression of breathing, shortness of breath, irregularity of pulse, anæmia, pallor of countenance, etc., are doubtless due to disorders of the vasomotor and nutritive systems. Morbid effects are also determined toward special organs; deafness, noises in the ear, muscæ volitantes, hemiopia, asthenopia, dilatation of the pupils, are well-attested symptoms.

**Pathological Anatomy.**—The anatomical changes induced by spermatorrhœa have not been investigated with sufficient care to furnish data of scientific value. Post-mortem examinations have shown the results of chronic inflammation of the mucous membrane of the prostatic urethra evidenced by induration and suppuration of the prostate, the ulceration extending toward the ejaculatory ducts and seminal vesicles. The latter have been found atrophied and sometimes notably enlarged and partially adherent to neighboring organs, the walls of the ejaculatory ducts are thinned, their lumina enlarged and their orifices dilated. No pathological alterations have been demonstrated in the lower portion of the cord connected with the genital organs. It is probable that in aggravated cases the nerve-cells concerned in the functions of the genital centers are exhausted, leading to paresis of the motor apparatus.

**Diagnosis.**—There can, of course, be no difficulty in diagnosticating pollutions; the subjective and objective signs of the disorders are sufficiently manifest to the patient. The question for the physician to determine is their pathological significance; of this their frequency of occurrence and systemic effects constitute the surest tests. Fortunately, in many cases the patient may be dismissed with the assurance that the symptoms of which he complains are physiological phenomena common to healthy persons, and are not at all indicative of disease.

The chief diagnostic difficulty lies in the differentiation of prostatic or other urethral discharges from spermatorrhœa. The physician is often consulted by patients suffering from prostatorrhœa or a gleety discharge, the persistence of which and the accompanying symptoms are interpreted by them as evidences of true seminal loss—they imagine themselves impotent, and become the prey of the most gloomy forebodings. This urethral hypochondriasis is quite common in young men of nervous, highly impressionable temperament.

While it is comparatively easy to identify a gleety discharge, the clinical similitude of spermatorrhœa and prostatorrhœa is so close that there may be considerable difficulty in distinguishing the two affections. They may both owe their origin to the same causes and be characterized by the same local symptoms—a more or less constant discharge of a clear viscous fluid which keeps the orifice of the urethra always moist or the lips agglutinated—an irritable weakness of the deep urethra, frequent micturition, sensation of weight or heaviness in the perineal region, pain and weakness in the loins, etc. Under the microscope the prostatic discharge is found to consist only of mucous corpuscles, epithelium-cells, *débris* from tubular glands, sometimes casts of follicles, with complete absence of spermatozoa.

No certain diagnosis of the existence of true spermatorrhœa can be made without microscopical examination of the fluid. The quantity of the discharge, its odor, color, consistence, or other physical characters do not furnish an absolute test of the presence or absence of spermatozoa. The absence of these bodies constitutes, it is true, negative evidence, but is insufficient, in view of the fact that the essential characters of the seminal fluid become altered in the course of the disease. In the early stage the semen shows no abnormal quality, but when the seminal losses become frequent and long continued the spermatozoa diminish materially in numbers, or they may be altogether absent. The prompt appearance of spermatic crystals in the evacuated fluid is, according to Ultzmann, a most characteristic and constant sign of the nonpresence of spermatozoa.

Under these circumstances the history of the case and the associated symptoms will assist in the diagnosis. If there is a constant escape of fluid not only after defecation, but from urethral straining, or during each micturition, and the clinical history shows the patient to have been addicted to sexual excess and to have suffered from pollutions, the evidence is in favor of spermatorrhœa, although the result of the microscopic examination be negative.

**Prognosis.**—The prognosis of spermatorrhœa is by no means so unfavorable as many writers have maintained. Death from exhaustion rarely follows pollutions, and its termination in epilepsy, degeneration of the spinal cord, dementia paralytica, etc., must be ascribed to primordial derangements of the nervous system, rather than to the seminal loss. In certain affections of the brain and cord spermatorrhœa is merely an incidental symptom, and sinks into insignificance in comparison with the graver lesions of the primary disease.

The prognosis is materially influenced by the cause which produced the disorder. Occurring in the course of fevers or convalescence from acute diseases it spontaneously ceases with restoration of the general health. The prognostic significance of pollutions occurring in the course of phthisis and other chronic diseases is measured chiefly by their debilitating and exhausting effect upon the general system. When dependent upon phimosis, stricture, varicocele, lesions of the urethral canal, anal or rectal irritations, it usually disappears with the removal of the cause. Occurring as a result of gonorrhœal inflammation of the genital tract, the prognosis is less immediately favorable, as the local causes of irritation are apt to persist for some time.

When the complaint is of recent date, and the emissions take place only at night and are unaccompanied by local structural changes or severe general symptoms, a favorable result may be confidently anticipated. Diurnal pollutions always carry with them a less favorable prognosis than nocturnal emissions.

In general it may be said that pollutions are amenable to treatment when the pathological changes are confined to hyperæsthesia or inflammatory lesions of the prostatic urethra and ejaculatory ducts. Where this inflammatory stage has been succeeded by an atony of the parts, with paresis of the motor apparatus, especially when associated with symptoms of general nerve exhaustion, the outlook is not nearly so favorable.

In regard to the age of the patient, it may be said that abnormal seminal loss occurring in early life as a result of masturbation has a more unfavorable prognosis than pollutions from sexual excess at a more mature age, when the activity of the organs is undergoing a physiological decline. On the other hand, the greater natural recuperative powers of youth constitute a favorable element of prognosis.

The family history and constitutional peculiarities of the individual have an important bearing upon prognosis. In persons of nervous, excitable temperament, with hereditary tendencies to hypochondriasis, epilepsy, insanity, etc., the inherited neuropathic state constitutes an unfavorable element in the prognosis.

**Treatment.**—A most important part of treatment is *prophylaxis*. Since, in the large majority of cases, abnormal seminal losses owe their origin to masturbation and sexual excess, the correction of these abuses constitutes the most efficient prophylactic measure. Most young men grow up in absolute ignorance of the physiology of this most important function of their physical being and of the ruinous effects its abuse entails. With the advent of puberty they perceive themselves subject to certain phenomena, the nature and significance of which they have never been taught. The habit of masturbation is contracted often thoughtlessly and innocently; it is practiced in utter ignorance of its evil effects, and the eyes of the victim are only opened to the danger when it has engendered a train of local and general disorders which persist long after the habit is abandoned.

The only way to combat the evil is to instruct the young in a knowledge of the physiological laws which pertain to their sexual organization. They should be taught that the sexual organs can not be excited into abnormal activity without doing violence to their health; that self-abuse is destructive to every endowment of true manhood, an infraction of Nature's law, the penalty for which is debility and premature decay of power. They should recognize that continence is not incompatible with health, that incontinence is not justifiable on physiological grounds, and that harlotry is not a safe substitute for marriage.

How best to impart this knowledge is an important problem in the education of childhood and youth. Its solution requires, in addition to courage, tact, discretion, and good sense. Medical men should take the initiative in this matter. One can not too strongly inveigh against the false sentiment and attitude of the profession in relation to the reproductive apparatus. It is a forbidden topic; its discussion is rebuked as immodest and profane; it is scarcely considered a proper and legitimate subject for scientific inquiry. All knowledge relating to that function through which life is perpetuated, and with the preservation of which is bound up the mental, moral, and physical health and well-being of the individual, is a sealed book, which only unworthy quacks and pretenders venture to open and with crafty cunning pervert to their own selfish ends.

In the treatment of spermatorrhœa, the form of the disorder, the exciting cause, and the coexistent constitutional conditions, which may stand in the relation of cause or consequence, must be considered.

**Special Treatment.**—When spermatorrhœa results from local organic causes, the removal of the cause usually suffices to bring about a cure more or less promptly. Phimosis and other irritable conditions of the glans should be relieved by circumcision; varicocele by palliative means or radical operation. Stricture and other lesions of the urethral canal should be treated by appropriate methods. When the disorder is dependent upon ascarides, piles, fissures, eczema, or other anal or rectal irritations, the removal of the local exciting cause is the first essential of cure.

In gonorrhœal prostatitis, epididymitis, and chronic inflammation of the neck of the bladder, which are so constantly accompanied by pollutions, the indications are to correct the material lesions which are the exciting cause of the seminal loss.

Spermatorrhœa, symptomatic of constitutional conditions, can be cured only by correction of the complicating cause. Obviously enough the cases dependent upon organic lesions of the cerebro-spinal axis are little amenable to treatment.

**Methodic Treatment** should be based upon a clear comprehension of the pathological condition present and adapted to the stage of the disorder. We have seen that in the large proportion of cases the exciting cause of the pollutions is a subacute or chronic inflammation of the prostatic mucous membrane and ejaculatory ducts with perverted innervation of the motor apparatus. The indications of treatment are to correct the hyperæsthesia and hyperæmia of the prostatic mucous membrane, to calm the irritability of the motor apparatus, and to diminish the excitability of the reflex spinal center. This can be most successfully accomplished by a combination of general and local measures. In a more advanced stage, when the local inflammatory condition has been succeeded by atony of the parts, a modification of treatment is necessary.

In addition to local structural changes, spermatorrhœa is characterized by nutritive and nervous disorders, hence a general tonic course of treatment is indicated. All hygienic and other measures calculated to build up the general health should be employed. The habits of life should be regulated, a substantial and nutritious diet ordered, highly seasoned articles of food should be proscribed; the last meal at night should always be light and simple. Alcohol is objectionable.

Any pathological modifications of the urine should be corrected, and the bladder thoroughly evacuated just before retiring. A full bladder favors erection, and as pollutions commonly occur toward morning, the patient should be directed to awaken and empty his bladder before morning. The expedient of using an alarm-clock renders this advice practicable. The patient should sleep on a hair mattress and pillow, with light covering, and always lie upon the side. In a dorsal position the distended bladder presses upon the return blood-vessels, thus increasing the congestion of the prostatic urethra.

Since pollutions occur from the excitation of dream impressions, which are often but the reflection of waking thoughts and desires, the patient should not allow his mind to be occupied during the day with sexual thoughts or imaginations; every form of erotic excitement should be avoided.

If the patient be married, abstinence from sexual intercourse should be enjoined for a period until the sexual organs regain their vigor by repose and proper treatment. Sexual intercourse, carefully regulated and indulged with moderate frequency, is beneficial in most cases, but excitement without gratification is always harmful.

Excessive and exhausting mental exercise should be avoided. Horseback riding is objectionable, on account of the tendency to cause local congestion and irritation of the sexual organs.

The tonic effect of hydrotherapeutic measures should be utilized; the patient should be directed to use saline douches night and morning to the genital parts and over the lower portion of the spine, followed by friction with a coarse towel until a healthy glow of the surface is established. In some cases a hip-bath, or hot douches alternated with cold, yield equally good results.

**Drugs.**—While no drug exercises a specific curative action upon spermatorrhœa, yet the use of certain remedies is undoubtedly beneficial when employed with discrimination and with an intelligent adaptation to the pathological condition present. In general, it may be said that sedatives are indicated in the early irritable stage of the disorder, while an essentially stimulating and tonic treatment is adapted to the more advanced, atonic stage.

Bromide of potassium exerts an undoubted calmative influence upon the abnormal excitability of the genital center. Camphor, lupulin, cannabis indica, and hyoscyamin, are also reputed to possess this property. In most cases I am accustomed to order the bromide, fifteen grains, in combination with tincture of the chloride of zinc, fifteen drops after each meal, with a double dose at bedtime. In an irritable, spasmodic condition of the ejaculatory apparatus, which, as before intimated, has certain analogies with irritability of the neck of the bladder attended with incontinence of urine, belladonna, or its alkaloid atropia, is one of the most efficient remedies. Gelsemium is another remedy of undoubted therapeutic worth, the value of which I have tested in numerous cases.

In the atonic stage, phosphorus, iron and strychnia, coca erythroxylon, quinine, and other nerve and nutritive tonics are indicated. They improve the tone of the nervous system, and relieve the neurasthenic symptoms which are so constant an accompaniment. Phosphorus may be given in the form of phosphide of zinc, phosphoric acid, or pure phosphorus, in combination with iron or strychnia, or both. Damiana, avena sativa, and other remedies of this class recommended for their aphrodisiac properties, I have used largely, without being able to convince myself that they possessed any special value. A most excellent remedy is a combination of a tincture of iron and cantharides in the proportion of twelve parts of the former to two of the latter, fifteen drops of which should be given after meals three times a day.

**Local Treatment.**—The seat of the pathological disorder and its easy accessibility suggest the use of direct topical applications.

The most effective means of relieving the irritability of the prostatic urethra is the systematic introduction of full-sized conical steel sounds, which overcome the hyperæsthesia and relieve congestion by distention and pressure and the contact of a cold surface. They should be used as large as the capacity of the urethra will permit, a congenitally small meatus being divided, if necessary, to admit the passage of an instrument 26 to 30 French scale. They should be introduced every other day, and allowed to remain from five to twenty minutes. The good effects of this procedure in relieving the abnormal sensitiveness of the urethra are as appreciable to the patient as to the surgeon.

The psychrophore or cold-water sound of Winternitz acts much in the same way, by combining the effect of mechanical pressure with the sedative influence of cold on the caput gallinginis and the prostatic urethra. By means of this appliance a current of any desired temperature may be kept continually flowing through the tube for fifteen to twenty minutes or longer at each sitting. It is desirable to begin with water of ordinary temperature, which may be gradually lowered.

A more indirect but sometimes equally efficient means of applying dry cold to the prostate is by the use of the rectal cold-water sound. It is especially indicated in cases where the existence of piles or inflammation of the seminal vesicles act as exciting or complicating causes of the seminal incontinence. The use of hot rectal douches is often followed by marked relief in inflammatory conditions of the prostate.

The application of astringents and caustics to the prostatic urethra constitutes a most efficient method of treatment, especially when the inflammation is circumscribed to a limited area involving the orifices of the ejaculatory ducts. The brilliant results of cauterization claimed by Lallemand and his followers have not always been substantiated by the experience of others. While it constitutes a most valuable resource in certain selected cases, the method has by no means the universality of application claimed by its originator.

Cauterization of the pars prostatica may be effected by the *porte remède* of Lallemand, by Langlebert's modification, which possesses certain advantages, or by any of the numerous urethral applicators devised for this purpose. The caustic may be used combined with an ointment by means of cupped sounds or ointment bougies, or in the form of suppositories by Dittel's *porte remède*, or other appliances for introducing suppositories of any desired strength. In using Dittel's *porte remède* for the purpose of cauterization a small suppository containing 0·02 grammes of nitrate of silver in combination with cacao-butter is inserted into the opening of the catheter, previously introduced into the urethra, and is pushed down and deposited in the prostatic urethra. This method possesses the advantages of accuracy and precision; a given amount of the remedy may be deposited at any desired point. The effect of cauterization is manifest in a sharp, stinging pain, sometimes bleeding, with more or less vesical tenesmus, which may be relieved by rest in bed and cold compresses to the perinæum. Ordinarily a single cauterization is insufficient, and the procedure must be repeated two or three times. A modified cauterization may be effected by the use of liquid injections or instillations of nitrate of silver by means of Ultzmann's or Keyes's deep urethral syringe.

Equally good results are obtained in the majority of cases by the use of astringents which may be introduced in the form of suppositories or liquid injections carried directly into the prostatic urethra. Weak solutions of nitrate of silver, carbolic acid, sulphate of zinc, tannin, hydrastis, pinus canadensis may be employed for this purpose.

**Electrical Treatment.**—Electricity, when intelligently employed, is a most valuable addition to our therapeutical resources, especially in an advanced stage of the disorder. In the generality of cases the use of the galvanic current yields the best results. The negative electrode should be introduced into the urethra or against the orifices of the ejaculatory ducts, and the positive pole be placed over the perinæum.

The current should be mild, rarely exceeding four milliampères, and the duration of its application at each sitting should be only a few minutes. In order to secure the best results from this treatment it should be employed at first daily, afterward two or three times a week, for two or three months. Its results in relieving the irritability of the urethra and arresting the discharges are often most gratifying.

Local faradization may be advantageously substituted for the constant current in cases characterized by diminished sensation or anæsthesia and deficient erectile power. When the faradic current is used it is better to introduce the cathode into the rectum, and apply the other electrode over the bulb of the urethra and external genitals. It should be used with caution, however, as its stimulating effect may be followed by an increase in the frequency of the pollutions.

Certain instrumental appliances in the shape of plugs or other devices for compressing the prostate, highly recommended by Trousseau and others, are of doubtful efficacy, besides being unpleasantly borne by the patient.

Castration is only mentioned to be condemned as an unscientific and barbarous practice.

Marriage as a remedy for abnormal seminal losses is often recklessly and injudiciously recommended. Unquestionably, moderate sexual intercourse constitutes a most efficient hygiene for the sexual organs, and in a majority of cases, when the pollutions have not induced actual impotence, it may, after a judicious course of treatment, be safely advised to complete the cure. But the view that a woman may be properly utilized as a therapeutic agent can not be too strongly condemned, as degrading to the dignity of womanhood and subversive of the higher ends for which marriage is instituted. Marriage is a partnership formed for mutual advantage, enjoyment, and the propagation of the species. Each contracting party should contribute a sufficient amount of virile energy and health to make these objects realizable. But a man whose contribution to the capital stock is an emasculate manhood, an impaired virility, and a barren capacity, cheats and defrauds his partner. Especially would we protest against the admissibility to marriage of worn-out *roués* and libertines, who have exhausted their sexual forces by a long course of sensual excess, and who seek to rekindle upon the altar of marriage the fires of a wasted and burned-out passion.

## II. IMPOTENCE.

**Definition.**—The power of copulation, or the ability to perform the sexual act, is the normal condition of every healthy adult during the physiological period of virility. The loss of this power constitutes impotence, and may be due either to organic causes, to incompleteness or absence of erection, or to a precipitancy of the reflex act of ejaculation before intromission of the penile organ and consummation of the act. The man who is impotent is practically sterile, although the semen may contain spermatozoa, for the mechanical reason that he is unable to deposit it in the generative tract of the female.

It is important to have a clear understanding of the distinction between impotence and sterility. While inability to accomplish the sexual act may be associated with loss of procreative power, yet one function may be preserved in entire integrity while the other is impaired or completely lost. There may be a complete abolition of the generative faculty in a man capable of consummating the sexual act normally and with full vigor. He is unable to procreate because his seminal fluid is absent or lacking in the essential elements of fecundation—the spermatozoa—or these bodies are altered, malformed, or deficient in vitality. As examples of the preservation of potency with loss of fecundating power may be mentioned a class of eunuchs whose testicles have been removed without other mutilation, and men whose vasa deferentia have been occluded by a double epididymitis, in whom strong sexual desire, the power of erection and ejaculation, attended with normal specific sensations, may exist in full activity.

Impotence may be absolute or relative; there may be a permanent absence of virility, or merely a temporary abeyance of this power. Since in its broadest sense impotence means inability to consummate marriage, it is evident that this definition embraces pathological conditions of a diverse character. It may depend upon abnormal physical conditions which act as mechanical obstacles to the introduction of the male organ in the vagina, or it may result from disorders of the nervous and muscular systems concerned in the mechanism of the complex act of erection and ejaculation.

It is a question whether the *impotentia coeundi* due to organic causes should properly be classed as true impotence. The subjects of this form of impotence are often endowed with strong desire and the mechanism of erection is normal; there is simply an inability to perform the sexual act under existing conditions. When these structural impediments are removed, as they often may be by surgical art, potency is found to be unimpaired.

**Physiology of Erection.**—Since erection is the essential condition of *potentia coeundi*, it is necessary to have a clear knowledge of the mechanism of normal erection in order to understand the pathological conditions which cause impotence. Erection is determined mechanically by the distention of the blood-vessels and erectile tissues of the penis with blood, causing an augmentation of its volume, with increased hardness, rigidity, and raising of the organ. This process is essentially under the control of the nervous system. Under the influence of the nervi erigentes which take their origin from the second, more rarely the third, sacral nerve, there is a relaxation of the muscular fibers of the cavernous tissue, permitting a free influx of arterial blood, entirely filling the short arterial branches anastomosing in the cavernous spaces. At the same time there is a compression of the efferent veins by the smooth muscular fibers of the corpora cavernosa, which hinders the reflux of the blood, and by its retention prolongs and strengthens the erection.

According to Landois, while the impulse to erection is obtained by increased supply of arterial blood, the full completion of the act is brought about by the activity of the following transversely striped muscles: 1. The ischio cavernosi, by their tendinous union surrounding the penis; when they contract they compress the root of the penis from above, and laterally, so that the outflow of blood is hindered. 2. The deep transversi perinei, perforated by the venæ profundæ coming from the corpora cavernosa, which in contracting compress these veins by their tense horizontal fibers. 3. The bulbo-cavernosus is concerned in the hardening of the urethral corpus spongiosum as it compresses the bulb of the urethra. All these muscles are partly under control of the will, whereby erection may be increased; normally, however, their contraction is excited reflexly by stimulation of the sensory nerves of the penis.

Ejaculation takes place normally when the penis is in full erection. During erection the orifices of the ejaculatory ducts are directed forward and the passage from the urethra to the bladder is closed by the swelling of the caput gallinaginis. As a result, while the semen may be readily discharged during erection, a barrier is formed to the passage of urine. During the act of erection the urethral glands begin to secrete, and their secretion may appear, if the erection is prolonged before ejaculation, as a clear viscid fluid at the meatus. The act of ejaculation is brought about by the reflex stimulation of the ejaculatory center in the spinal cord. When the seminal fluid is poured out through the ejaculatory ducts it collects in the bulbous urethra, between the erectile tubercle behind and the compressor urethræ in front, until by mechanical distention of the canal it excites a reflex contraction of the bulbo-cavernosus muscle of a spasmodic character whereby it is forcibly expelled in a series of gushes from the urethra. Immediately preceding and coincident with ejaculation a sensation of voluptuous excitement is experienced.

It is probable that the spermatozoa ejaculated represent the accumulation stored in the seminal vesicles rather than the immediate secretion of the testicles.

Eckhard showed that erection can be excited by stimulation of the erigent nerves, but is impossible after their division. He also found that erection occurred from stimulation of the higher regions of the cord as well as the pons and crura cerebri, from which he concluded that the motor impressions were conveyed by fibers of the erigent nerves which pass down the cord. Goltz found that erection was much more powerful and promptly excited by irritation of the sensory nerves of the penis after division and separation of the lumbar segment of the cord; and from this he concluded that there was an independent center for erection in the lower portion of the cord; also, that the brain exercised a more or less dominating, inhibitory action upon erection—a conclusion confirmed by the clinical manifestations of psychical impotence.

Irritation of the spinal cord of the most varied character from disease, concussion, or other injury, may occasion erection; indeed, priapism is one of the first indications of incipient tabes. Stimulation of the medulla oblongata by asphyxiated blood or by muscarine excites erection.

Erection may be excited by peripheral or psychical impressions. As illustrations of the former, may be mentioned the morning fullness of the bladder, various local irritations of the urethra, bladder, and rectum, also the mechanical stimulation of the sensory nerves of the penis from friction of the glans in masturbation. As illustrations of the latter may be instanced lascivious or lustful thoughts, the sight or contact with women. While partly under the control of the will, erection may manifest itself independently of the will, or it may fail, notwithstanding the most pressing desire or the strongest effort of the will. Mere imagination may excite erection, and it may be arrested or neutralized by a sentiment of fear, disgust, or modesty.

The act of ejaculation is in a measure also controlled by the will; after a certain degree of excitement, however, the ejaculative sensation becomes so exalted that the motor influences which complete the act are irrepressible. The inhibitory action of the will over the reflex center is exceptionally developed in certain individuals. This repressive influence of the will is not infrequently utilized by married men, who, in order to avoid impregnation, are accustomed to delay emission until after withdrawal of the penis from the vagina.

From these physiological facts it will appear that the normal evacuation of the seminal fluid is a complex motor act the mechanism of which involves the nervous, vascular, and muscular systems. In a perfectly healthy condition there is a harmonious and co-ordinate action of these elements.

In normal coitus erection and ejaculation usually result from the combined influence of central and peripheric stimuli. The central impulse awakened by desire or erotic excitement is quite sufficient to excite erection, but insufficient to arouse the ejaculation center which transmits the motor influence to the seminal vesicles and stimulates them to contraction and expulsion of their contents. The mechanical stimulus of the sensory nerves of the penis from contact with the rugæ of the vaginal walls determines ejaculation. In a healthy state this coefficient action of the mechanical stimulus is essential to the discharge of the reflex, and the transition into a morbid state may be measured by the progressive diminution of the peripheral impulse necessary to provoke ejaculation. In the large class of cases of impotence from irritable weakness there is an abnormal excitability of the motor apparatus with increased mobility of the reflex center, and ejaculation takes place without mechanical cause, during intromission, or even before actual contact.

It will thus be seen that in the large proportion of cases impotence is essentially an *ataxia* of the genital system characterized by incoordination of the expulsive and retentive muscles, and presenting certain analogies with tabes. This disordered action is due to a disturbance of the equilibrium of the motor influences emanating from the brain, the sensory nerves, and the reflex spinal center.

**Classification.**—Different divisions of the several forms of impotence have been made by different authors. The following classification appears to the writer to be the simplest and most scientific. According to the more prominent etiological element present in each case, the following forms may be distinguished:

1. Organic impotence. 2. Psychical impotence, including relative impotence. 3. Irritable impotence. 4. Paralytic impotence.

**Organic Impotence.**—Under this head are grouped various defects, mutilations, malformations, and vicious directions of the penile organ, which physical conditions preclude the possibility of successful sexual intercourse.

The cases of complete absence of the penis are of too rare occurrence to merit consideration. Small size of the penis is a relative cause of impotence. The penile organ may be abnormally short, or its available length may be reduced by the contiguous existence of a tumor, scrotal hernia, elephantiasis, or an overhanging or protuberant belly which prevents the close approach essential to copulation. Excessive size of the penis has been mentioned by certain authorities as a cause of impotence. Cases are instanced in which stone in the bladder or strictures have determined a hypertrophy of the penis until it acquired such dimensions as to render intromission impossible. Extreme size of the penis involves only a relative incapacity for intercourse.

Hypospadias and epispadias when extensive, with or without extreme curvation, involve impotence as well as sterility simply from the vice of conformation which prevents the deposition of the semen in the genital canal of the female. A slight hypospadias does not necessarily involve impotence or even sterility. The semen may be deposited in the lower part of the vagina and impregnation follow. A short frænum may cause distortion of the penis and prevent intromission.

Distortions or deviations in the direction of the penis, due to inflammations or deposits of various kinds in the erectile tissue or fibrous sheaths of the corpora cavernosa, may be sufficiently pronounced to prevent intromission. Cicatricial induration, gummata, and calcifications of the corpora cavernosa have been assigned as causes.

The various diseases of the testicles have, as a rule, a closer causal connection with sterility, but they are not infrequently causes of impotence. Anæmia and atrophy of the testes, tubercular affections, syphilitic sarcocele, sarcomatous and cancerous infiltrations, by displacing or disorganizing the secretory structures of the organs, may be followed bv both sterility and impotence.

**Psychical Impotence.**—No fact better establishes the controlling and dominating influence of the mind over the genital function than the existence of this neurosis. An individual may have all the appearances of virility, with strong sexual desire, yet when he attempts sexual intercourse he fails, from a nervous apprehension of his inability to perform the act. In consequence of the high degree of nervous excitement, the inhibitory action of the brain over the genito-spinal center is intensified, and the erection fails at the critical moment.

This form of impotence, which is of a purely psychical order, has been termed imaginary impotence, since the individual is impotent from the sole fact that he *imagines* himself to be impotent. It is most commonly met with in the young or newly married, and is often the expression of inexperience rather than of incapacity.

A young man contemplating matrimony, in order to test his virility or fitness for marriage, may attempt intercourse with a prostitute and fail, and in consequence imagine that he is impotent. He does not reflect that the conditions of sexual intercourse in married life and illicit cohabitation are altogether different. Indifference or disgust, inspired by some act or speech of the prostitute, shame, the fear of contracting disease, all tend to induce a state of mental perturbation which takes away the power of performance.

A newly married man, in the eagerness to consummate the marriage, may fail simply from the impetuosity which attends overwrought desire. The mortification which results from this failure in the marriage-bed is apt to beget a timidity and distrust of his powers which may render him really impotent. Fortunately, in most of these cases confidence is regained by repetitions of the act, and this abnormal condition spontaneously disappears under the corrective influence of the sexual hygiene of married life.

The influence of fear and dread on the production of erection may sometimes be studied, as suggested by Ultzmann, in the examination of such patients by sounds. "When they have unfastened their clothes and stretched themselves on the table the penis is seen gradually to shrink, grow smaller, and to move in a worm-like manner. The corpora cavernosa become smaller and harder. To the touch the penis feels cartilaginous; the skin shows transverse folds due to the contraction of the corpora cavernosa. These appearances can only be explained by spasmodic contraction of the organic muscular fibers, which are imbedded in the trabeculæ of the corpora cavernosa. This constriction is a manifestation of the action of the inhibitory nerves of erection, stimulated by the fear and dread of catheterism. In exactly the same way, then, other purely psychical influences stimulate the action of the inhibitory nerves, and the patient is at such moments impotent."

Among the causes of this form of impotence may be sexual indifference, sudden shock, violent emotions, as excessive grief, fright, intense and long-continued mental preoccupation, etc. As an instance of the latter may be mentioned the oft-quoted case of Grimaud de Caux, that of a celebrated mathematician, whose thoughts at the critical moment always went wandering toward the solution of some complicated problem. His wife finally succeeded in keeping him "on amorous thoughts intent" sufficiently long for an ejaculation, by the expedient of making him slightly intoxicated, so that he forgot his problems. Roubaud relates cases of impotence in previously healthy men following the shock of a railway accident, grief at the death of a beloved wife, etc. Ultzmann instances similar cases which have come under his observation, also impotence from the loss of money and property.

The sufferers from this form of impotence have in most cases been addicted to masturbation or other abuse of the generative organs and still have pollutions or spermatorrhœa, the existence of which they accept as an evidence, and at the same time as sufficient cause, for this fancied loss of virility.

**Relative Impotence.**—By this term is understood the inability to perform the sexual act with certain women, while with others it may be normally consummated. This form of impotence is not infrequently found in loveless marriages contracted from mercenary motives, where the parties are of incompatible temperament. Unquestionably the spiritual element of love, as well as affinity and mutual attraction, play an important *rôle* in exciting *desire*, which is an essential preliminary to the proper performance of the sexual act. Many men and most women are so constituted that this moral sentiment is a prerequisite or necessary condition of physical passion. Without it the sexual nature remains dormant and indifferent.

Apathy, coldness, or repugnance on the part of a wife often extinguishes sexual desire on the part of the man, and may be responsible for this relative impotence, which immediately disappears outside the marriage-bed. A man may be impotent with a frigid and indifferent wife, while the opposite is the case with a passionate prostitute.

**Irritable Impotence.**—The impotence due to irritable weakness of the genital organs, with abnormal excitability of the reflex centers, represents by far the largest proportion of cases. Perfectly normal coitus involves not only desire and erection sufficiently powerful for penetration, but also sufficiently lasting to admit of a series of movements during a certain time, which act as a mechanical stimulus to the reflex discharge. The inability to have a powerful and lasting erection, and premature ejaculation, are the distinguishing features of this form of impotence, which varies in degree in different cases. There may be only feeble desire, the erection may be partial, irregular, or of such short duration that the ejaculation of semen takes place *ante portas*—before intromission. In another class of cases sexual desire and erection are strong and penetration possible, but ejaculation takes place prematurely, during or immediately after intromission, rendering satisfactory intercourse impossible.

While this form of impotence may be manifest in persons of a highly excitable temperament, simply from a peculiarity of nervous organization, the origin of the trouble may be most commonly traced to masturbation or other forms of sexual excess. As a result of this abnormal irritation of the genital passages there have been induced a hyperæmia and hyperæsthesia of the mucous membrane of the prostatic urethra, in consequence of which the nerves which excite the reflex act of ejaculation respond to an abnormally slight stimulus, either peripheral or central.

Such individuals will always be found to have a hypersensitive urethra. Upon the introduction of a sound the canal is found sensitive throughout. When it reaches the prostatic portion the hyperæsthesia is so pronounced that it occasions the most intense pain. The mucous membrane of this region seen under the endoscope is found to be hyperæmic, swollen, of a cherry-red or livid color, and bleeding easily. Associated with this morbid alteration in the mucous membrane, which renders it especially vulnerable and disposed to take offense at the slightest provocation, there is oftentimes an enlargement and patulousness of the ejaculatory ducts, permitting of a more ready escape of the contents of the seminal vesicles.

The impotence which not infrequently follows gonorrhœal inflammation, especially when complicated with posterior urethritis and epididymitis, stricture, etc., also certain affections of the prostate, is doubtless due to the prostatic inflammation, causing irritability of the nerve branches which transmit the reflexes. Impotence from this cause is usually of temporary duration, and spontaneously disappears with the restoration of the deep urethra to a normal condition.

**Paralytic Impotence.**—By many writers, only those cases in which impotence is absolute and permanent are classed in this category. Obviously, however, this restriction is not admissible, since cases of the true paralytic variety of impotence are sometimes, though unfortunately very seldom, curable. In this form of impotence the nervous mechanism of the genital apparatus is so disturbed that normal erection rarely occurs. In the more advanced stage not only is there loss of power of erection, but sexual desire is completely absent.

In some cases partial or feeble erections may occasionally occur, sufficiently strong even to render possible the penetration of a capacious vagina, but the semen, instead of being discharged in a violent jet or gush, oozes or dribbles away in a sluggish, passive manner. This may be due to a paralysis of the bulbo-cavernosi muscles, by the contraction of which normally the semen is forcibly projected from the urethra. The secretory functions of the seminiferous organs, as well as the nerves and motor apparatus, are oftentimes in a state of organic weakness.

Upon examination, the genital organs are often found to be undersized, pale and cold, the penis flaccid, the testicles soft and atrophied, the scrotum relaxed, and the whole aspect of the external genitals weak, withered, and senile. The integument is, as a rule, insensitive to the action of the galvanic current. Upon examination with a full-sized sound the urethral mucous membrane is found to be deprived of its normal sensibility.

While this most aggravated and intractable form of impotence is often due to the exhaustion which follows masturbation and sexual excess, it may be the local expression of some constitutional state or dyscrasia, or profound lesion of the nervous system. Several years since I had under my care a medical man who had sustained a severe injury of the spine by being thrown from his carriage; as a result of which there followed a marked atrophy and wasting of the external genitals, with complete extinguishment of sexual desire and erection. Various writers have mentioned instances of atrophy of the testis and penis following injuries or concussions of the cord.

Diseases of the brain and cord which abolish or greatly diminish the reflex excitability of the nerves supplying the generative organs, softening of the brain, cerebral hæmorrhage, tumors of the brain, chronic myelitis, especially in an advanced stage, may be attended with complete anaphrodisia; also certain constitutional affections, as lepra, Bright's disease, diabetes, the cachexia and anæmia of syphilis, may depress or entirely abolish sexual desire and power.

In connection with the impotence symptomatic of conditions of the general system, the impotence due to drugs may be properly considered. The prolonged and excessive use of certain drugs, such as opium, cannabis indica, bromide and iodide of potassium, chloral, arsenic, etc., may seriously impair or entirely destroy sexual power. It is well known that Orientals not infrequently become impotent at an early age from the use of opium and hasheesh. Exposure to the fumes of antimony, lead, sulphide of carbon, arsenic, etc., in industrial occupations, may be followed by loss of virility.

The depressing effect of tobacco, alcohol, and other cerebral excitants upon the genital functions is a matter of common observation. It may be said that the anaphrodisiac effect of tobacco is not universal, being influenced by conditions of temperament or idiosyncrasy. The excessive use of beer is said to diminish sexual power; the action of alcohol, in first stimulating, then blunting, nervous sensibility, is well-known; the immediate effect of drunkenness is to excite the sexual desire while taking away the power of performance. Old and confirmed alcoholics are often entirely impotent. The pathogenesis of this symptomatic impotence must be sought for in the depressant action of the drug upon the brain and spinal cord, associated with more or less profound alterations of the nervous structures.

**Etiology.**—The causes of organic impotence have been fully set forth in the description of the mechanical obstacles concerned in its production. The etiology of other forms of impotence is, in the majority of cases, identical with that of spermatorrhœa. It may be positively affirmed that the diminution or complete loss of the power of sexual intercourse can in most instances be traced to abuse of the sexual organs by natural or unnatural methods. Exception is, of course, made for certain cases of impotence symptomatic of general diseases—cachexiæ, cerebral diseases, or lesions of the spinal cord involving the centers of erection.

**Symptomatology.**—It is not surprising that two diseases which are united by such close etiological lines should have largely a common symptomatology. A description of the symptoms that characterize impotence would consist chiefly in a repetition of what has been detailed in this section under spermatorrhœa.

It may be said, however, that when the fear or the consciousness of impotence is ingrafted upon the train of mental symptoms engendered by spermatorrhœa their hypochondriacal character becomes more accentuated. The loss of virile power always carries with it a sense of personal degradation; and when a man becomes dominated by the fixed idea that he is deficient in the most essential attribute of manhood, he is apt to sink into a state of profound melancholia. Indeed, no mental state is more depressing in its influence than the dread of impotence. Whether the impotence be real or only fancied, its demoralizing effect upon the individual is none the less pronounced.

**Prognosis.**—The prognostic significance of the different forms of impotence varies according to the pathological condition present. In many cases organic impotence is absolute and permanent from the very nature of the physical causes which constitute the obstacle to successful intercourse; other cases, however, are remediable by surgical means. The prognosis of psychical impotence is almost uniformly favorable. The subjects of this form have ordinarily a normal genital apparatus, with strong desire and erection; the trouble lies in the fact that the nervous excitement is so exalted as to nullify the power of erection during the act of coitus. This disturbing element is usually of transient duration; after a single successful intercourse confidence in one's powers is regained as readily as it was lost. Scarcely less favorable is the prognosis in most cases of impotence from irritable weakness of the genital organs. Proper local and general treatment, supplemented by the sexual hygiene of married life, rarely fails to effect a cure.

The prognosis of the paralytic form of impotence is generally gloomy. In cases dependent upon structural lesions of the cerebro-spinal axis there is rarely hope of cure. In other cases due to prolonged and inordinate self-abuse, the tone of the sexual organs may often be restored by local and general tonic measures.

**Treatment.**—Many cases of impotence due to abnormities or lesions of the genito-urinary organs admit of surgical relief. Hernia, hydrocele, varicocele, etc., may be corrected by operative procedures; tumors of the penis, if nonmalignant, may be extirpated; the redundant integument of elephantiasis may be removed; hypospadias and epispadias may be cured by plastic operations, with re-establishment of the lost or impaired genital function. The deviations and curves of the penis from wounds of the urethra, indurations from cavernitis, ossification or calcification of the corpora cavernosa, are rarely remediable by surgical measures. On the contrary, when distortion of the penis arises from syphilitic infiltrations the outlook is favorable. Under the influence of specific treatment the indurations may melt away and the organ be restored to a normal condition. The reflex impotence which is consecutive to various lesions of the genital and perigenital regions, such as phimosis, herpes vegetations, granular patches or stricture of the urethra, diseases of the bladder and rectum, frequently disappears upon the correction of the cause.

The impotence which not infrequently follows gonorrhœa, prostatitis, vesiculitis, inflammation of the testicle and cord, is usually cured by the correction of the material lesion upon which it depends.

The large proportion of cases which come under the physician's observation are examples of the irritable or atonic form of impotence, characterized by a too precipitate ejaculation. The patients are generally young men who have been addicted to the practice of masturbation and suffer from one of the forms of seminal incontinence. These cases are almost invariably characterized by marked hyperæsthesia of the prostatic mucous membrane, irritability of the ejaculatory ducts, and erethism of the genital nerve-centers.

The first indication is to correct the local irritation. This can be most effectively accomplished by topical applications. The methods of local treatment may be summed up as follows: (1) The daily passage of metallic sounds of sufficient size to distend the urethra; (2) the use of the cold-water sound or psycrophore; (3) the treatment of the pars prostatica by the direct application of caustics and astringents; (4) the use of electricity.

The application of these methods has been fully considered in the treatment of spermatorrhœa, and to avoid repetition the reader is referred to this section. Of especial service in irritable weakness is the cauterization of the caput gallinaginis.

The good effect of local treatment is not only manifest in the diminution of the morbid sensitiveness of the prostatic urethra, but in the production of frequent and more vigorous erections, the moral effect of which upon the patient is always most favorable.

As regards the use of electricity, it may be said that the constant current gives the best results in the generality of cases. As previously pointed out, the faradic current is more stimulating, and is therefore contraindicated in cases of seminal weakness characterized by pollutions, from its tendency to increase their frequency. Faradization is, however, especially useful in the paralytic form of impotence, when there is a paresis of the bulbo-cavernosi muscles and other structures concerned in the ejaculation of the semen. By its continued use the muscular apparatus concerned in erection and the expulsion of the semen is toned up and energized.

Cases of the purely psychical type are in many instances susceptible of psychological cure. The subjects of this form of impotence are, as a rule, nervous and highly excitable. It is necessary, first of all, to gain the patient's confidence, and impress him with the certainty of cure; very often, under the physician's confident assurance of his functional capability, his nervous apprehension will be allayed and the impotence disappear. In other cases it may be necessary to give for a few days a placebo in small doses, or some medicine of reputed aphrodisiac power. The faith of the patient in the virtue of the remedy will often suffice to assure the desired effect. An ingenious French writer has recommended the expedient, often successful, of giving the patient any indifferent remedy, with the positive prohibition of any attempt at sexual intercourse until a certain quantity has been taken. It succeeds so well that the patient rarely takes the prescribed quantity. A new emotion—a resolution to resist his desires—having replaced the fear of failure, the impotence vanishes with the cause which produced it. However paradoxical it may appear, the absolute prohibition of coitus is in many cases the surest way to render it possible.

It is important in all cases to study the temperament and peculiarities of each individual case and adapt the treatment accordingly. Some patients are more impressed by what acts upon the imagination, others by what appeals to the intelligence. The physician should not essay the *rôle* of the Christian scientist—of assuring the patient that his trouble is merely fanciful, that it exists only in his imagination, and that, if he will only bring his mind to the conviction that his disease has no existence, it will immediately vanish. However much the patient may be impressed at the time by this logic, afterward the recollection of an experience which caused him so much humiliation is sure to beget a lively apprehension of its repetition under similar circumstances, and the dread of failure reasserts itself. Instead of endeavoring to convince the patient that his trouble is trivial and of no importance, it is better in these cases to respect his fears, and counsel a course of preparatory treatment before making a further test of his virility.

The constitutional remedies and general hygienic measures which are best adapted for the various forms of seminal weakness have been fully considered in connection with the treatment of spermatorrhœa.

In nervous, hypochondriacal patients, change of air, tonics, sea-bathing, with complete abstinence for a time from all attempts at coitus, are to be recommended. With the re-establishment of the general health there is frequently a spontaneous awakening of the genital sense, evidenced by more frequent and lasting erections, which the patient always interprets as a proof of virile power.

## III. STERILITY.

The general subject of sterility has assumed a new phase in professional estimation within the last few years, from a recognition of the fact that sterile marriages, for which the woman was formerly held exclusively responsible, are not infrequently due to a lack of procreative power on the part of the husband. This opinion was based upon a confusion of copulative with procreative power. It was assumed that any man with a good development of his genital organs, and capable of consummating sexual intercourse in a normal manner, was possessed of the power of propagating his species. It is now recognized that a man may possess the *potentia coeundi* unimpaired, and even unusually developed, and yet be deficient in the *potentia generandi.*

The comparative frequency of sterility in the male can not be definitely determined, from the very nature of the case. When only two factors are involved, it might appear easy to identify one by eliminating the other; but the conditions which control generation are complex and obscure, and not always susceptible of analysis. Either or both parties to a sterile marriage may contract a new connection, and fruitful results may follow in either or both cases. Few, however, would subscribe to the opinion promulgated by the late Dr. Gross, that in more than sixteen per cent of sterile marriages the fault is to be ascribed to the man and not to the woman.

**Definition.**—Sterility on the part of the male is an inability to produce offspring. He may be possessed of virile power and have a discharge of seminal fluid, yet if this contains no spermatozoa, or at least no fertile spermatozoa, he is sterile.

**Physiological Characters of the Semen.**—Since procreative power depends upon the *quality* of the semen, it is necessary to have an exact knowledge of the normal composition of the semen and the conditions of its secretion in order to elicit the significance in relation to sterility of the pathological modifications this fluid may undergo.

The semen is a composite substance made up of the secretions of the testicles, the seminal vesicles, and of the accessory glands—the prostate, Cowper's glands, and the glands of the urethral mucous membrane. Of these various secretions which collectively constitute the seminal fluid, that from the testicles alone contains the fecundating principle. The office of the accessory glands is to furnish secretions which dilute the semen, lubricate and prepare the urethra for its reception, and facilitate its discharge.

The semen when ejaculated is an opalescent mass of varying consistency, which coagulates upon exposure to the air and then becomes more fluid. It possesses an alkaline reaction, and a characteristic odor which has been compared to that emitted by freshly sawed bone. This odor is derived from the secretions of the accessory glands, probably the prostate, since it is present in seminal fluid which does not contain the testicular secretion.

The semen consists of ninety per cent water with only ten per cent of solid matter; of this latter, six per cent consists of organic constituents, including the spermatozoa, three per cent of earthy phosphates, especially phosphate of lime, and one per cent of chloride of sodium. Of the organic constituents, semen contains spermatin, an albuminous body resembling casein in reaction. Besides spermatozoa, the microscope shows spermatic cells, epithelium from the prostate and urethra, and molecular detritus. The spermatic cells have been termed the breeding-places of the spermatozoa.

Spermatozoa presents the appearance of threadlike filaments, with an oval head, a middle portion tapering to a tail extremely fine at the other end, and are endowed with movement and activity. In fresh, healthy semen "they may be seen to move rapidly with a whiplike or wriggling motion across the microscopic field." They are also endowed with considerable vitality, which may be preserved from forty-eight to eighty-four hours after ejaculation. It is claimed that this vitality may be conserved for a period of eight days in a favorable medium, in the generative organs of the female. An alkaline medium favors their vitality, while an acid medium destroys them. Water checks their movements, "causing their tails to curl up in a loop." Solutions of salt, sugar, albumen, potash, and soda may revive motionless spermatozoa, while cold, and solutions of metallic salts and acids, arrest their movements (Fig. 1).

The amount of semen discharged at a single ejaculation varies from one half to one drachm or more, depending upon different conditions and circumstances. Frequent repetition of the sexual act diminishes not only the absolute quantity of the seminal fluid, but more notably the number of the contained spermatozoa. The greater proportion of the fluid comes from the accessory glands. It has been observed that in complete occlusion of the vasa deferentia, shutting off the testicular secretion, the amount was not materially diminished.

The secretion of the seminal fluid begins at an early age and continues for an indefinite period, depending upon the individual, his habits, mode of life, etc. Spermatozoa begin to appear at the age of puberty, and may continue to appear, but with rapidly decreasing frequency, after the sixtieth year; they have been found as late as the eighty-sixth year. Before puberty and in old age no spermatozoa, only spermatic granules, are found. The period at which spermatozoa normally cease to appear may be anticipated by masturbation and other forms of sexual abuse.

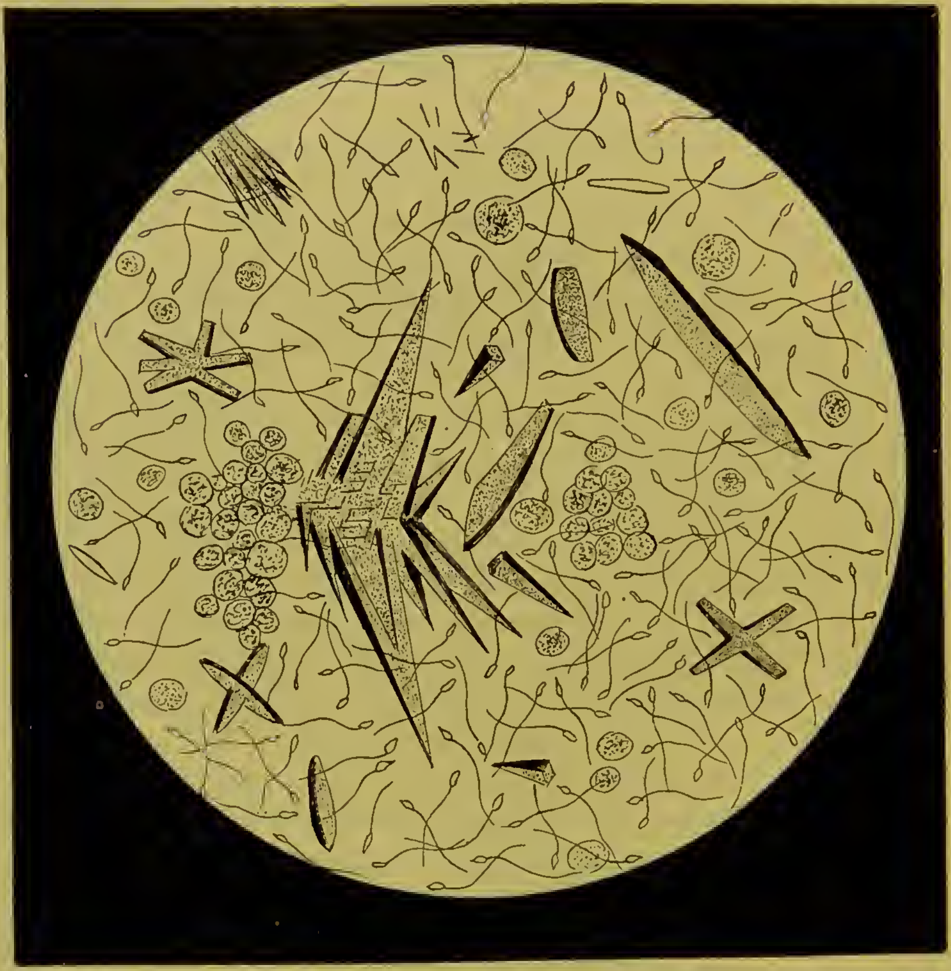

Fig. 1.—Spermatozoa in last drops of urine, with alkaline reaction. (Peyer.)

The continuous secretory activity of the seminiferous organs during the entire period of virility renders the male human being apt for procreation at all times and seasons. This is in marked contradistinction to the sexual instinct and power in other animals, which are active only at certain seasons when the animal is "in heat," and dormant at others. Indeed, this ceaseless physiological activity of the reproductive organs in man constitutes a most marked anthropological differentiation. It must not be assumed, however, that the peculiar sexual organization of man demands for its health and preservation the full amount of exercise of which it is capable. The testicles afford examples of organs whose development and functional activity are not lost by disuse. A man may live to quite an advanced age in a state of continence, with comparative or complete inactivity of the sexual organs, without material impairment of their functional capacity.

**Pathological Modifications.**—The pathological modifications of the seminal fluid which are connected with sterility relate both to its quantity and quality as well as it color, and may be classified as follows: 1, Aspermia, absence of semen; 2, oligospermia, diminished quantity of semen; 3, oligozoöspermia, diminished number of spermatozoa; 4, azoöspermia, absence of spermatozoa; 5, chromospermia, colored semen.

It is evident that the first of these classes excludes all the others, since no seminal fluid whatever is ejaculated. The second and third conditions frequently coexist, and may owe their origin to the same pathological cause; the sterility resulting therefrom is relative rather than absolute.

**Aspermia.**—This term is applied to that form of sterility in which the act of coitus, though normal in other respects, does not culminate in the ejaculation of semen from the orifice of the urethra. The nonemission may be due to a failure of the reflex act of ejaculation in response to the mechanical stimulus of coition; it may be caused by alterations in the seminal passages which prevent its entrance into the urethra, or by some mechanical obstacle in the urethra which obstructs its outward flow.

Aspermatism may be absolute and permanent or relative and temporary. Absolute aspermia is characterized by an entire absence of semen, either in coitus or in the form of nocturnal pollutions. During coition, no matter how prolonged the act, no fluid is discharged, except a few drops of viscid fluid representing the secretion of the urethral glands. This form is usually congenital; it is not attended with any marked abnormity in the development of the external genitals, and can only be explained on the assumption of the nonexcitability of the reflex center of ejaculation.

The absolute aspermia caused by mechanical obstruction to the passage of the semen into the urethra may owe its origin to congenital defects or vices of conformation, such as occlusion, absence or vicious direction of the ejaculatory ducts. In the majority of cases, however, it is an acquired affection, and due to obliteration or occlusion of the ejaculatory ducts by various inflammatory affections of the prostate. Cicatricial occlusion of the duct may follow an abscess or any suppurative inflammation of the prostate. In tubercular affections of the prostate the infiltrations may disorganize the gland and by their pressure occlude the ejaculatory ducts. Division of these canals in perineal lithotomy, or from injury in the extraction of a calculus, may permanently destroy their function. According to Reliquet, the ducts may be blocked up by sympexions or concretions formed in the seminal vesicles.

The third variety of aspermia, which is relative rather than absolute, is caused by an obstruction situated between the pars prostatica and the meatus. Since semen is discharged into the urethra, there is in this class of cases a retention rather than an absence of seminal fluid, and it has therefore been properly termed *false aspermia.* Moreover, the condition is fortunately relievable by surgical treatment.

*Stricture of the Urethra* is the most common cause of the retention of semen within the urethral canal. A stricture which readily permits the passage of urine may, under the changed vascular conditions which attend venereal excitement and erection, have its caliber so encroached upon as to prove impervious to the denser seminal fluid. Under these circumstances the ejaculated semen regurgitates back into the bladder, to be passed with the urine when the erection subsides, or slowly escapes from the urethral orifice in a dribbling, intermittent manner. Fortunately, the sterility from stricture is amenable to surgical measures, and disappears with the removal of the obstacle that occasioned it.

A tight phimosis may prove an obstacle to the normal forcible discharge of the semen, and thus cause sterility. A number of cases are on record in which sterility from this cause was cured by the operation of circumcision.

**Relative Aspermia.**—This comparatively rare form is distinguished by the peculiarity that ejaculation of semen does not take place during coitus, but subsequently, as a pollution during sleep. While the most prolonged and exhausting efforts during coition or long-continued manipulation (masturbation) fail to provoke the seminal discharge, nocturnal pollutions under the influence of erotic dreams are not infrequent.

This form of aspermatism may be due to anæsthesia or a diminished excitability of the sensory nerves of the penis, which normally respond to the mechanical stimulus of coition by reflex contraction of the ejaculatory muscles. The absence of voluptuous sensations, which characterizes this condition, would confirm this view. Since in this class of cases emission never occurs when the patient is awake, the influence of the inhibitory nerves upon the center of ejaculation may be exaggerated or otherwise perverted. When this restraining action is suspended during sleep, pollutions take place.

Relative aspermia presents certain analogies with the relative or psychical form of impotence, and, like it, is often of a temporary character; one morbid condition may replace the other, the patient being at one time aspermous, at another impotent; the same pathogenic cause may be invoked for both.

**Temporary Aspermia.**—In still another class of cases ejaculation takes place at certain times and under certain circumstances, while at other times it fails completely. Temporary aspermatism is found chiefly in persons who suffer from irritative debility of the genital organs. The majority of patients thus affected have been addicted to masturbation and venereal excesses, or have suffered from repeated attacks of gonorrhœa. The inflammatory and other changes in the prostate thus induced exert a paralyzing influence over the nervous apparatus, which controls ejaculation. With the improvement in the local condition the ejaculatory function may be restored in comparative or complete integrity.

**Oligospermia.**—By this term is understood a diminution in the quantity of the semen discharged by ejaculation. A variety of causes may contribute to the decrease or entire suppression of one or other of the secretions which collectively constitute normal semen. When the testicular secretion is diminished, the associated condition known as oligozoöspermia is present. Both are normal conditions of advanced age, when the physiological activity of the seminiferous organs have begun to decline.

Oligospermia may be congenital from feebleness, or inherent debility, or nondevelopment of the sexual organs. It is more often acquired, and occurs in the course of exhausting diseases, or as one of the manifold manifestations of neurasthenia. As a result of malnutrition or faulty innervation, the secretory activity of the sexual organs is impaired. A marked diminution of the seminal fluid is found in cases where the prostatic secretion is arrested from inflammatory or suppurative disease of this organ, or where the seminal ducts are occluded.

**Oligozoöspermia** may be defined as the diminution of the number of spermatozoa. As is well known, the semen of different individuals varies not only in the amount discharged at each ejaculation, but also in the relative number and proportion of contained spermatozoa. Ultzmann has endeavored to fix as a standard of comparison the number of spermatozoa which should appear in the field of vision of a given objective. He asserts that "normal healthy semen should show in the microscopic field, with a Hartnack objective 7 and ocular 3, about one hundred living spermatozoa."

The spermatozoa vary not only in number, but in their period of development, activity, and other physical qualities, and consequently in fecundating power. In oligozoöspermia the spermatozoa are not only diminished in number but often altered in quality; when small and feebly vitalized they involve a diminution, when motionless or dead an entire loss, of procreative power.

This condition is a common result of masturbation and the frequent seminal losses induced by this habit. The testicles can not respond to the inordinate demands made upon their functional capacity by the production of healthy and well-formed spermatozoa. The injurious effects of natural sexual excess are no less pronounced. Nature requires a certain period of repose for the development of fully formed spermatozoa. It has been observed that when coitus takes place quite frequently the semen becomes more watery and scanty, and the spermatozoa are fewer and smaller, until after a certain number of repetitions of the act they may entirely disappear from the ejaculated fluid, which consists merely of the secretions from the accessory glands.

The more pronounced and permanent forms of oligozoöspermia result from various affections of the testes, epididymis, and vasa deferentia. Partial occlusion of the efferent vessels of the testes from unilateral epididymitis, monorchidism, etc., may cause a diminution of the number of spermatozoa. Pressure upon or disorganization of the testicular gland-tissue from the presence of tubercular or syphilitic neoplasms may cause a gradually increasing diminution in the number of spermatozoa, until they finally cease to appear. In this case there is a transition of this condition into azoöspermia.

**Azoöspermia.**—This condition implies an entire absence of spermatozoa from the semen (Fig. 2). Although the seminal fluid deprived of the testicular secretion is fatally impaired in its fecundating capacity, there is no notable diminution of its quantity or obvious macroscopical change in its physical characters. It is perhaps more fluid, but the property of coagulation and the color and odor peculiar to normal semen remain unchanged. When placed in a test-tube and allowed to settle, it will be found that the whitish sediment is less dense and abundant in proportion to the liquor seminis than in normal semen. This sediment, according to Ultzmann, consists mostly of epithelium from the seminal ducts and urethra, seminal granules, and very often also of numerous well-formed spermatic crystals. The so-called *spermatic* or Böttcher crystals are larger, more numerous, and appear more quickly than in normal semen.

Azoöspermia not infrequently results from sexual abuse or excess. The sterility thus induced is usually of a temporary character; with rest and time, healthy and fruitful spermatozoa are again reproduced. It is a matter of common observation that a newly married pair who indulge excessively in sexual intercourse may remain sterile for a long period, unless impregnation has taken place at the first embrace or soon thereafter, before the quality of the semen has become deteriorated. If, now, they are separated for a period until the spermatozoa have time to mature and fully develop, impregnation takes place when they come together again.

General diseases, especially diathetic conditions, may cause an absence of spermatozoa by weakening the organism. The emasculating influence of diabetes is generally recognized. Spermatozoids are seldom found in the genital passages of persons who have died from tuberculosis.

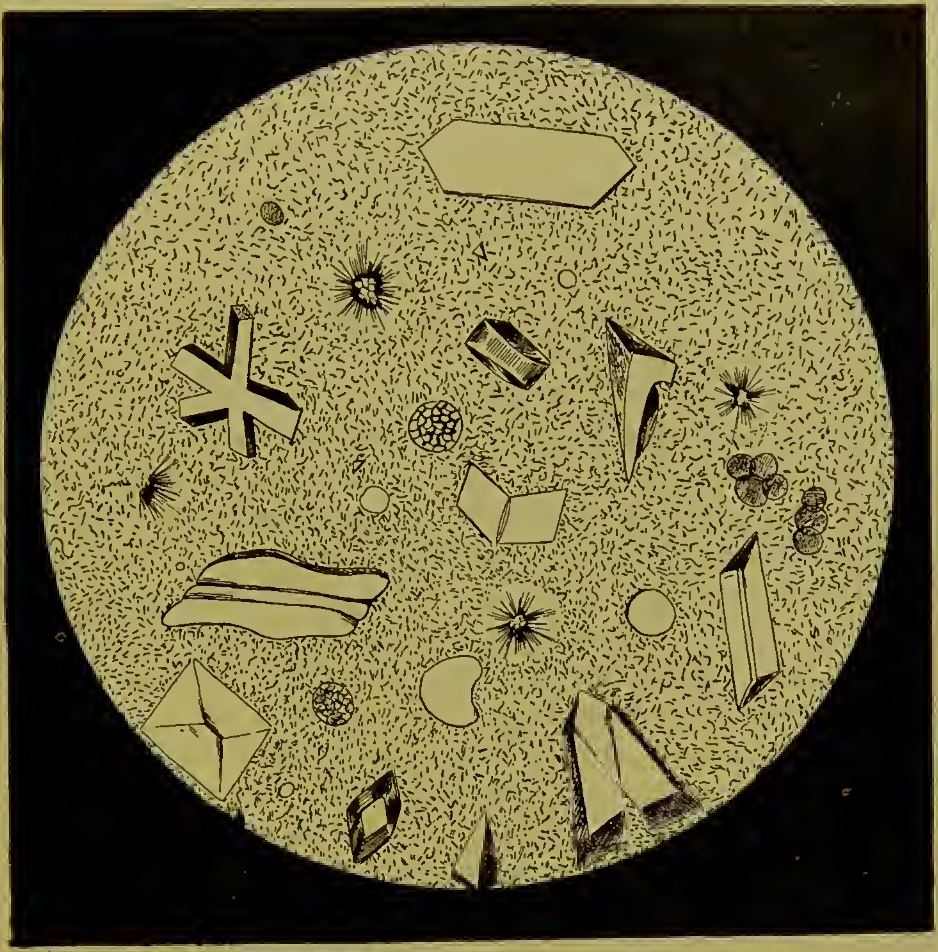

FIG. 2.—Spermatic fluid in azoöspermia. (Peyer.)

From the nature of its etiology azoöspermia is usually permanent. It may be congenital or acquired. Permanent absence of spermatozoa is occasionally, though very rarely, an idiopathic affection.

The congenital anomalies or vices of conformation which cause azoöspermia are absence of the testes, failure of the testes to descend (cryptorchidists are usually but not invariably sterile), and congenital deficiency of the vasa deferentia.

The most common cause of the acquired form is gonorrhœal inflammation of the testes and spermatic cord. If the epididymitis is bilateral and results in occlusion of both vasa deferentia, the sterility is absolute.

Tubercular epididymitis, syphilitic sarcocele, cystic or solid tumors of the testicle, or parenchymatous orchitis from whatever cause, may interfere with the secretory structures of the organ to such a degree as to render the patient azoöspermous.

**Chromospermia.**—This term I have coined to express the different modifications in color which the semen presents under certain conditions, the exact pathological significance of which, especially in relation to sterility, has not been carefully studied. Some of these color changes in the seminal fluid present certain analogies with similar modifications in the secretion of the sweat-glands. It is probable that they occur much oftener than is generally supposed, but escape observation for obvious reasons, the conditions under which the semen is discharged presenting few opportunities for examination—mostly, in fact, in masturbators, who are not disposed to confess their practices, much less to place *en évidence* visible and palpable proofs.

The following varieties of chromospermia have been observed in diseases of the genital apparatus:

1. *Red or Reddish-brown Semen*, due to an admixture of blood, and which may properly be designated as *hæmatospermia.* The coloring material may arise from hyperæmia or a congested condition of the prostatic urethra, induced by gonorrhœal inflammation. It may come from the seminal vesicles, as a result of acute inflammation (spermatocystitis) or tubercular and cancerous disease. Ultzmann endeavors to differentiate the source of the blood in bloody pollutions, by the character of the stains. When from the pars prostatica "the dried stains on the linen appear irregularly colored, on the rusty-brown stains are usually small blood-specks, while in the second case the stains appear evenly colored, which indicates an intimate mixing of the blood with the semen, as might happen in the seminal vesicles. When the stains are of a brownish-yellow color there is usually an admixture of pus with the blood."

Hæmatospermia may also result from the intense congestion of the mucous membrane of the prostatic region, which follows masturbation and sexual excess.

*Yellow or Greenish-yellow Semen.*—A greenish-yellow color is imparted to semen by the admixture of pus. The purulent discharge may come from the prostatic neck in the course of an acute gonorrhœa, or from epididymitis followed by a catarrhal inflammation of the vasa efferentia, the result of gonorrhœa. Terillon has collected a number of cases of bilateral epididymitis, in which the ejaculated fluid was of a yellowish tint verging on green. While it contained abundant pus-corpuscles and a few large granular corpuscles, spermatozoa were nearly always absent. The same condition may result from inflammation of the seminal vesicles. Ultzmann states that, when the pus comes from the neck of the bladder, "the stains have not an even yellow color, but the pus appears on the dried seminal stain in smaller or larger patches, irregularly distributed; when from the seminal vesicles, the stains appear evenly colored."

*Wine-colored Semen.*—The nature of this stain excited considerable comment until it was discovered to be due to indigo; under the microscope the presence of crystalline indigo is readily demonstrated, and serves to differentiate it from bloody semen, to which it bears a macroscopic resemblance. The intimate admixture of the stain gives it a more even coloring than is usually seen in hæmatospermia.

*Grass-green Semen.*—This color is said to be due to the admixture of pus with strong indigo-colored semen.

*Blue Semen* is mentioned by Ultzmann as a probably rare modification of the grayish-white color of normal semen. Its occurrence is problematical.

As before intimated, the pathogenic influence of these color modifications upon the vitality of the semen has not been carefully studied. From the fact that greenish-yellow semen is almost always characterized by the absence of the essential anatomical elements, it would seem evident that pus is destructive to the evolution and life of the spermatozoa. Heitzmann's observations on spermato-cystitis would indicate that there may be a transformation of spermatozoa into pus-corpuscles.

The etiology and symptomatology of sterility have been indicated in the foregoing description.

**Prognosis.**—The prognosis of sterility will depend upon the cause and nature of the pathological condition present; in general, it may be said that it is not favorable.

When due to a mechanical impediment in the urethra to the passage of semen, which may be removed by surgical art, the prognosis is favorable. When the obstacle is situated more deeply in the ejaculatory ducts, the vasa deferentia, or involving the secretory structures of the testicle, their inaccessibility precludes the possibility of direct treatment, and the prognosis is correspondingly unfavorable. Nevertheless, we often find that the azoöspermia from gonorrhœal inflammation and that attending syphilitic infiltrations is of temporary duration. With the subsidence of the epididymitis, the inflammatory engorgement occluding the efferent vessels may be resorbed and their lumen be restored; likewise, syphilitic infiltrations in the body of the testicle may undergo involution either spontaneously or as the result of treatment. In eighty-three cases of bilateral epididymitis due to gonorrhœa, collected by Liégeois, spermatozoa reappeared in the semen of only eight of these patients. The prognosis in cases of syphilitic origin is always more favorable.

Onanismal azöospermia, or the sterility from sexual excess, is usually of temporary duration, and disappears under the corrective influence of time and repose.

**Treatment.**—The treatment of male sterility does not, as a rule, yield favorable results. The exceedingly rare cases in which phimosis causes sterility may be cured by circumcision. The sterility resulting from coarctation of the urethra, or other impediment situated between the orifices of the ejaculatory ducts and the meatus, may be cured by removal of the cause. Absolute aspermia presents no available point for treatment.

In the partial stenosis of the vasa efferentia from gonorrhœal inflammation, and in obstruction of the ejaculatory ducts, faradization of the testicles has been recommended with the view of exciting their secretory activity. It is claimed that the *vis a tergo* of the increased seminal flow serves to dilate the partially occluded vessels.

In occlusion of the vasa efferentia from bilateral epididymitis little hope of successful treatment can be offered, especially if the imperviousness is complete and has existed for some time. Under the influence of iodide of potassium internally and the local use of resolvent ointments, occasional cures of chronic cases have been reported. The very hopelessness of these cases emphasizes the necessity of prophylaxis. In all cases of bilateral epididymitis prompt and vigorous antiphlogistic treatment should be instituted and kept up until the indurations have undergone complete involution.

In advancing atrophy of the testicles good results may sometimes be obtained by galvanization. Where the tubular structures of the testicle are pressed upon or blocked up by diffuse or circumscribed syphilitic infiltrations, specific treatment—iodide of potassium and mercurials, either in the form of inunctions or plasters—should be energetically employed.

Ultzmann reports favorable results in the treatment of chromospermia when the blood or pus comes from the prostatic urethra from cauterization of the caput gallinaginis. When the blood and pus come from the seminal vesicles, cauterization does not accomplish much.

# GONORRHŒA IN THE FEMALE.

By ANDREW F. CURRIER, M.D.

**History.**—The term *gonorrhœa*, like so many others which have been retained in medical terminology, is based upon a misconception. It is attributed to Galen, who used the word γονόῤῥοια, from γονή or γόνος, *semen*, and ῥεῖν, *to flow* (De Locis Affectiones, vi, 6 and xiv, 10). He considered it an affection of the vessels which are designed for the excretion of semen, and not of the genital organs proper. The term *blennorrhœa*, which is in common use with many writers, especially French writers, and derived ultimately from βλένος, *mucus*, and ῥεῖν, *to flow*, is more nearly expressive of the true condition of affairs, especially in the gleety stage, while *pyorrhœa*, which signifies *a discharge of pus*, would be still more correct. All these terms are inaccurate, however, for they do not indicate whether the discharge is from the urethra, the conjunctiva, or any other tissue which is capable of secreting pus or mucus.

But the term γονόῤῥοια is older than Galen, for it may be found in the writings of Hippocrates and Herodotus, and their observations were probably of phenomena similar to those which were observed by Galen. In the writings of Paulus Æginetus, Actuarius, and Trallianus, gonorrhœa is described, but only as it occurs in males. Aretæus observed that women who suffered with gonorrhœa experienced gnawing pains in the sexual organs, and desire for coitus, while such sensations were not experienced by male sufferers. In all the ancient writers who have made any reference to gonorrhœa in women, this condition seems to have been confused with leucorrhœa and abnormalities of menstruation. The contagiousness of the disease was clearly recognized by them, whether it occurred in males or females. The ancients also recognized the presence of condylomata which are so common an accompaniment of gonorrhœa in women, descriptions of them being given by Ætius, Aretæus, Paulus, Æginetus, and Archigenes. Cedrenus observed that condylomata when ulcerated cause infection during coitus (Synopsis, Paris, 1647, page 266), and a similar observation was made by Palladius (Vita patrum, cap. 148). Condylomata were also recognized by Galen and Hippocrates, the latter recommending their destruction with knife or caustic (De Natur. Mulierum, vol. ii).

The most ancient description of gonorrhœa is said to be found in a Chinese manuscript written by the Emperor Hoang-ty in the year 2637 B. C. It is referred to by Verrier in an article entitled De la blennorrhagie chez les peuples de race jaune (Le Médecin, Paris, October 10, 1886). In this ancient document gonorrhœa is described as an inflammation of the urethra and vagina, and often of the bladder, which is accompanied with a white or red discharge. The symptoms in the female are said to be similar to those in the male, namely, pruritus ani, heat and swelling of the vagina, burning pain in micturition if the urethra is involved, a discharge of green or yellow pus, and pain extending from the hypogastrium to the perinæum. Such a description is a fairly satisfactory one, but one is inclined to be skeptical as to the authenticity of the record.

A Japanese manuscript of the ninth century A. D. is also said to contain descriptions of the various forms of venereal disease, including gonorrhœa (Scheube, Virchow's Archiv, March, 1883, page 448). Again, in the fifteenth chapter of Leviticus Moses refers to a condition which made Israelites possessing it ceremonially unclean, and this has been interpreted as signifying gonorrhœa. Josephus states that the Israelites contracted venereal disease from the Moabites while on their journey through the wilderness to Canaan. Many other facts in connection with the history of the nations of antiquity concur in leaving little doubt that venereal diseases were about as rife with them as with us, and it is safe to assume that gonorrhœa was one of them.*

The absence of checks and restraints upon the appetites and passions among savage and barbarous people would suggest the prevalence of venereal disease among them, and such seems to be the fact. Accurate information in regard to the condition of women among such people is extremely difficult to obtain. I have made extended inquiries, through physicians in the employ of the War and Interior Departments, concerning venereal disease among the women of our native Indians, but have failed in getting as definite information as could be desired. It is easily ascertained that syphilis is exceedingly common among them, for that is evident, without interrogation. The medical officers also speak, with scarcely an exception, of the almost utter absence of virtue among Indian women, more particularly the young ones, but to obtain definite data as to the amount of suffering which they experience from venereal disease seems impossible, both on account of their ignorance and their unwillingness to submit to the necessary examination and treatment.†

What the influence of religion in the form of Nature-worship, which with its licentious rites and orgies was practiced by so many of the nations of antiquity, may have been in the way of producing this disease which is so intimately associated with excesses and filth, we can only conjecture.

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* Some of the foregoing data, and many other curious and interesting ones, have been collated by Dupouy in a work entitled La prostitution dans l'antiquité, Paris, 1887.

† See the author's paper on a study relative to the functions of the reproductive apparatus in American Indian women, Trans. Amer. Gyn. Soc., vol. xv.

**Etiology.**—The statement of Fournier that the causes of gonorrhœa may be reduced to contagion and excessive irritation of the urethra, though applicable to the male sex, is equally applicable to the female when slightly modified.

The concept of the relationship of the disease to germs and fungi, however ancient, was impossible of verification until the development of modern physiological chemistry and the improved microscope, hence our knowledge of the subject in this direction is of very recent date. Donne's spore trichomonas vaginalis was discovered in discharges from the vagina in 1844; Salisbury's crypta gonorrhoica in 1868; Jousseaume's algue genitale in 1872; Hallier's konotecium gonorrhoicum in 1872.

These discoveries marked a new era in the study of gonorrhœa, and were prophetic of the revolution which was soon to take place in the investigation of infectious disease. The new science of bacteriology was beginning to assume definite proportions. But it is not within the province of the present article to discuss the question of etiology except in a very general way. The article on the Etiology of Urethritis should be consulted for such information.

Another important chapter in the evolution of our present knowledge concerning gonorrhœa in the female was furnished by the investigations of Nöggerath. In 1872 appeared his first paper on this subject (Die latente Gonorrhöe im weiblichen Geschlecht), and in 1876 his second (Latent Gonorrhœa, especially with regard to its Influence on Fertility in Women). The conclusions of Nöggerath were accepted by Angus Macdonald, Amann, and Hennig, but not by gynæcologists in general. He maintained that gonorrhœa was not only extremely common, but that it often remained latent for years; that newly wedded women were very often infected by husbands who had long since ceased to show any active symptoms of gonorrhœa—sterility, dysmenorrhœa, perimetritis, salpingitis, and ovaritis resulting; and that gonorrhœa, either in the male or the female, was practically incurable. Nöggerath barely missed the discovery of the gonococcus, for he says (Trans. Am. Gyn. Soc., vol. ii, page 268): "In my work published four years ago I expressed the hope that the key to solve the question might be found in the presence of a fungus peculiar to the secretion of women affected with latent gonorrhœa, of which my researches up to that time had given much encouragement. I have, however, not followed them up for several reasons, principally owing to the fact that I found the same fungus in discharges from very young children, in cases where I was unable to trace all the points in the etiology of the case that would be necessary to establish the value attributable to the presence of this growth." Subsequent investigations, both clinical and microscopical, have fully demonstrated the value and importance of Nöggerath's observations.

In 1879 Neisser, of Breslau, announced the discovery of the gonococcus, a microbe which he claimed was characteristic of gonorrhœa (Ueber ein der Harnröhrentrippers eigenthümliche Mikrokokkenart, Centralbl. für die med. Wissen., 1879, page 28). He asserted its constant presence in gonorrhœal pus, and its identity with a microbe which is found in purulent *ophthalmia neonatorum.* It was usually found in groups upon the surface of pus-corpuscles, being first round in shape, and then developing into the form of a long oval. Then there was a division in the cell with an interval between the two segments, and then elongation at right angles to the former plane of division. He also stated that this micrococcus differed morphologically and functionally from all other forms (Die Mikrokokkus der Gonorrhöe, Deutsche med. Wochen., 1882, No. 20). The investigations of Neisser were speedily supplemented by those of many others, who confirmed the statements which he had made. The list of such investigators is a long one, and includes such names as Weiss, Bokai, Brieger, Cheyne, Ehrlich, Rücker, Gaffky, Aufrecht, Bumm, and Oppenheimer.

**Definition.**—To define gonorrhœa in the female in a manner which shall be concise and at the same time comprehensive, is not an easy matter. The disease is, of course, identical with gonorrhœa in the male, so far as its pathological characteristics are concerned. It is an infectious disease, which primarily involves a larger or smaller area of the mucous membrane of the genital tract in the great majority of cases. It may extend within to the peitonæum, or without to the skin. It may involve the mucous membrane which is not included in the genital tract, and other serous membranes besides the peritonæum. Its ultimate cause is probably the gonococcus Neisser, though other microbes are almost constantly found associated with this one, and the fact of mixed infection is generally admitted. It is frequently identical with purulent ophthalmia, especially in the newborn. Its phenomena are those which belong to inflammations of the mucous and serous membranes, but vary in intensity and in the area involved in different cases. The hypothesis of the microbial origin of the disease is a convenient one to explain many cases of the dormant or latent variety, in which a history of recent impure sexual intercourse is wanting.

But belief in the pathogenic power of the microbe gonococcus does not imply that its demonstration is possible in every case of gonorrhœa. The area over which or within which it may find lodgment is an extensive one, the number present at a given moment may be small, and the keenness of vision and skill in investigation of different observers vary within wide limits. It has long been my opinion, in which I am supported by some of the ablest and most conscientious observers, that in most cases clinical phenomena will enable one to determine a diagnosis of gonorrhœa even though gonococci be not found. In cases to which medico-legal importance is attached their demonstration is of value, though even in such cases it is not always imperative. Recent opinions upon this subject vary. Kratter (Occidental Medical Times, June, 1891) states that without a bacteriological examination it can not be determined, in a case of suspected rape, whether a vaginal discharge is traumatic or not, and that the detection of gonococci is proof of the presence of gonorrhœa, which has probably been conveyed in the sexual act. But gonorrhœa can not be positively excluded if gonococci are not found. Vibert and Bordas (Jour. de Médecine de Paris, March 8, 1891) think it premature to give diagnostic value to micro-organisms found in vaginal and vulvar mucopurulent discharges. They made observations upon the discharges from the genitals of six little girls, upon each of whom a criminal assault had been perpetrated by men found to be free from gonorrhœa. In the vulvar discharge in each instance were diplococci, identical morphologically and bacteriologically with the gonococcus Neisser.

Boret (Provincial Medical Journal, Leicester, England, April, 1891) agrees with the opinion last mentioned, after investigation of cases of vulvitis in which there was no suspicion of impure contact or indecent assault.

The disease varies greatly in its intensity in different individuals, variations in susceptibility obtaining in this as in all other infectious diseases. The personal equation in such matters is one which can never be rigorously defined in advance. With some women the disease is sharp in its attack, severe in its course, and apparently over in a few weeks, especially if the treatment has been intelligently designed and carried out. With other women the symptoms are mild, of long duration, and recurrent at intervals, even when there is no suspicion of new infection. In other words, this disease, like other infectious diseases, may be severe or mild, and may continue a very long or only a short time.

**Classification.**—Little attempt was made to subdivide or classify gonorrhœa in women prior to the period which began with Nöggerath. By many of the older writers the disease was practically ignored, by others it was little understood, being briefly described as an inflammatory disease of the vagina, less often of the urethra or endometrium. In recent times it has been seriously questioned by more than one thoughtful writer whether gonorrhœa of the vagina ever exists as a primary condition.

In all descriptions of disease the simpler the classification the better and the less confusing. I think all clinical purposes may be satisfied by regarding gonorrhœa in women as acute and chronic, remembering at the same time that there may be repeated acute attacks, and that the disease may long remain dormant or latent. The difference between the acute and chronic conditions consists mainly in difference in the intensity of the symptoms. A number of writers speak of the diminished number of gonococci in the chronic state, and this is reasonable, since they are associated with pus-cells, and these are not abundant in the chronic condition.

**Variety of Forms.**—So great is the variety of opinion as to the frequency of different forms of gonorrhœa that I am persuaded its phenomena must vary with the locality, whether from difference of individual habits, varying effects of climate, or some more obscure cause. Bumm, whose writings and investigations upon this subject during the past ten years demand for him a respectful hearing, found as a result of examining and studying 53 cases from their very beginning during a period of five months or more (Frauenarzt, 1891, vi, 345), that the endometrium of the vaginal portion of the cervix was the seat of gonorrhœa in seventy-five per cent of the cases, the endometrium of the corpus in fifteen per cent, and the mucous membrane of the tubes in 3·5 per cent. He formerly questioned the existence of a vaginal gonorrhœa in adults. He now believes that it seldom occurs in adults as an acute process, and never as a chronic one.

Steinschneider (Jahresb. der Schles. Gesellsch. für vaterl. Kult., 1887; Breslau, 1888, lxv, 49) has found the urethra the seat of the disease in the majority of acute cases, and the cervical endometrium in the majority of chronic cases.

Eraud (Cong. Internat. de Dermat. et de Syphilig., 1890, p. 642; Le bulletin méd., 1889, iii, 1080) found gonorrhœal urethritis and endometritis with equal frequency. The gonococcus was obtained from the endometrium by examination of the scrapings obtained with the curette. In only a few instances was he able to find the gonococcus in scrapings from the corporeal endometrium. He believes that the gonococcus does not live upon pavement epithelium, and hence, if found in the vagina, that it is there by accident, having migrated thither from the cervix uteri with the discharges from the cervical endometrium. In his opinion, therefore, gonorrhœal vaginitis is secondary to metritis.

Ingria (Gazetta degli Ospedali, 1887, viii, 805) thinks urethral gonorrhœa is far more frequent than vaginal, but the existence of the latter is not doubted.

In a total of 750 cases of gonorrhœa in women seen by Jullien in Paris hospitals there were 286 cases of acute or chronic urethritis.

Sänger (Annales de gynécologie et d'obstetrique, 1890, xxxiii, p. 111) finds gonorrhœa most frequently in the cervical endometrium; vaginitis is less frequently seen, the vagina receiving infectious matter without being always influenced by it. He has not found urethritis of very common occurrence.

Horand (Lyon médical, 1888, lix, p. 251) examined 5,090 prostitutes and 764 children, many of the latter the victims of rape, between the years 1882 and 1888. In the women he found that the urethra was most frequently the seat of gonorrhœa, while in the children it was the vagina. (Among 85 children he found vaginitis in 68; in 33 of the latter he found gonococci; and in 20 the vagina alone was diseased. He also found gonococci in 20 cases of vaginitis in women, but in 239 other cases he was unable to find them.) Welander (Le bulletin médical, 1889, iii, p. 3) found gonococci more frequently in the urethra than elsewhere, especially among prostitutes.

Thus, though there has been strong opposition to the idea of the existence of primary gonorrhœal vaginitis, that opposition is becoming less pronounced. The principal objections that have been offered are that the gonococcus does not live upon the pavement epithelium of the vagina nor in the secretion of the vagina which is normally acid. If it happens to be found in the vagina, it is there by accident in connection with primary disease of the urethra or endometrium.

And yet the objectors to vaginal gonorrhœa admit its presence and frequency in young children, and its occasional occurrence in young women.

The case is, therefore, not conclusive against those who insist strongly upon the presence and frequency of vaginal gonorrhœa. Even Bumm has admitted that he had found the gonococcus in and under the deeper epithelial layers of the vagina (Neumann, Internationale klinische Rundschau, 1888, ii, p. 217), and his earlier statement that it was found only on cylindrical epithelium was denied by Jadassohn (Deutsche medicinische Wochenschrift, 1889, xv, p. 683). Welander (*loc. cit.*) admits the difficulty of finding the gonococcus in the vagina for the reasons given, and also on account of the great number of other microbes in the vagina with which the gonococcus might be confused, but he thinks that a negative result in this direction has not a sufficiently demonstrative value. Furthermore, he has seen several cases which he could only interpret as essential gonorrhœal vaginitis. Urethritis was also present; the vagina was the seat of an acute purulent catarrh, and so tender to the touch that a speculum could not be used. In nine such cases gonococci were found, though they were also found in the uterus. In six other cases of gonorrhœal vaginitis there was no involvement of the uterus. The differentiation which Welander would make between gonorrhœal vaginitis and ordinary vaginal catarrh consists in the abundance of pus-cells in the former, and in the diminution of the microbes which are usually present in the vagina. Zeissl has found vaginal gonorrhœa twenty times more frequent than urethral (quoted by Ingria, *loc. cit.*). Terillon (Le bulletin médical, 1890, iv, p. 837) affirms that gonorrhœa involving the uterus is preceded by gonorrhœa of the vagina, the former developing from the latter, and the former frequently culminating, as Bernutz and Goupil have shown, in pelvic peritonitis. There is, then, great confusion among investigators concerning the frequency and significance of the various forms of gonorrhœa, also concerning the diagnostic value of the gonococcus, its presence in this or that locality, and upon or within this or that tissue, and whether it is this organism alone which causes disease, or a combination with other organisms. There is also great difficulty in deciding between the true gonococcus and the false with which it is morphologically identical (Bumm, Bockhardt). On the one hand, we are told it is always easy to find the microbe (Horand); on the other, that in fifty per cent of cases it can not be found (Schwarz). Equally puzzling are the statements that it is always a superficial disease (Bumm, Sänger), and that it may involve the tissues as well as the secretions (Schmitt, Wertheim, Wiener klinische Wochenschrift, 1890, iii, p. 476). My own experience with this disease, which has been in a field rich with opportunities during the past twelve years, has given me opinions which are decided and to my own mind convincing, though I confess that my faith in the influence of the gonococcus is less firm than it was a few years ago. If it is mixed infection which produces the severer phenomena of gonorrhœa, why may it not be possible to discard the influence of the gonococcus altogether? for it seems to be fairly determined that the presence of the staphylococcus and streptococcus is always injurious. Again, if the pseudo-gonococci which are so often associated with the gonococcus produce phenomena which resemble, if they are not identical, with those produced by the genuine microbes, a diagnosis dependent upon such a basis is always open to doubt.*

Therefore, until bacteriologists can reach something like settled conclusions in regard to the part played by microbes and with something like unanimity, I think, with Nöggerath, Sänger, and others, that we must depend mainly upon clinical phenomena in determining our diagnosis. I am still far from believing, with Welander, that the view that gonorrhœal vaginitis is a common or the most common form clinically, of the disease, is obsolete. Possibly the view of that author that it is a very common form among children and young women, especially young prostitutes, is correct; but it must also be remembered that the greater number of cases of gonorrhœa occur in just such individuals, the possible changes in the vaginal epithelium of those who have been long married, or a long time prostitutes, or of those who have borne children, together with the better opportunities for vaginal drainage in the latter furnishing them with a certain degree of protection against gonorrhœal vaginitis which the others referred to would not have. At any rate, in the cases of gonorrhœa in women which I have seen the greater number have come with vaginitis as the most conspicuous symptom. They have been in most cases young prostitutes, or young married women, or young women who have complained that they were victims of seduction. With these the external manifestations have also been most frequent. Next in frequency were those who suffered with pelvic peritonitis of gonorrhœal origin, especially prostitutes and recently married women. Fewer in number were those who suffered with urethritis and cystitis, and they were not infrequently women in mature life. Next in frequency were those who suffered with abscesses, glandular inflammations, and endometritis. I do not say that in my opinion endometritis is the least frequent manifestation or variety of gonorrhœa, but *in my experience* it is the form which has caused least personal annoyance to the patient, and fewest acute symptoms upon which a diagnosis could be based.

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* Neumann (Internationale klinische Rundschau, 1888, ii, p. 217) states that Bumm has found several diplococci in the vagina, similar morphologically to Neisser's microbe, and differing very little in their cultures, but not causing gonorrhœa. Bockhart has produced pseudo-gonorrhœa, urethritis, and epididymitis from pure cultures of staphylococci and streptococci, not differing in appearance from ordinary gonorrhœa.

The disease may have the following forms or varieties, which may appear singly or in combination, and with or without complications: 1, vulvitis; 2, bartholinitis; 3, vaginitis; 4, urethritis; 5, endometritis; 6, salpingitis; 7, ovaritis; 8, peritonitis.

Gonorrhœa in a woman always implies a precedent gonorrhœa in some one else, which has been acquired by infectious contact, but not necessarily by the sexual act. It is quite conceivable that it may be communicated through the medium of towels, handkerchiefs, articles of furniture, or even water-closet seats. It never exists *de novo* either in man or woman, *ex nihilo nihil fit.* Whether all vaginal and endometrial discharges are or are not infectious is another matter. Considering the number and variety of microbes which constantly inhabit both the vagina and endometrium, it is quite possible that under favoring conditions these may be the cause, or a cause, of inflammation in the male urethra, as Bockhart has shown, but that is quite a different thing from gonorrhœa, the disease *par éminence* of dissipation, sexual excess, and vice. As gonorrhœa is in the majority of cases a disease of youth in the male, it is equally so in the female, partly because the greater number of those who are likely to be exposed to it are young, and partly, as is supposed by some writers, because of changes in the epithelium as life advances which enable it to offer greater resistance to infecting media.

**Period of Incubation.**—The time which elapses from the reception of the infectious material to the appearance of the symptoms of gonorrhœa is not usually a long one. Of course, the symptoms appear more quickly when the mucous membrane of the genital tract is hyperæmic, as during menstruation or pregnancy, than under ordinary conditions. In some cases it has seemed to me that influences from the nervous system, such as fear, anxiety, shame, and remorse, have hastened and heightened the symptoms. In the very young we should expect indications of the disease more quickly than in those of mature years. From two to five days may be regarded as the usual period of incubation for this disease in women, and I have not observed that the duration of this period varied from one form or location of it more than for another.* Why one portion of the genito-urinary tract should first show evidence of infection rather than some other portion, may be due in part to greater susceptibility, but more to efficient exposure. Thus, the primary form of the disease in children is almost always vulvitis; in young women it is more frequently vaginitis; while in the mature, and those who have borne children, it is often urethritis or endometritis. The crypts and follicles with which the genito-urinary mucous membrane abounds also explain the difficulty of eradicating the disease, and the frequency of the recurrence of acute attacks, when favoring conditions cause renewed activity in secretions and germs which may have been long retained in a dormant or inactive condition. I have never agreed with Nöggerath's earlier views, that the disease was necessarily incurable. It is doubtless radically cured in many cases, but we must not forget that there are many others, perhaps many which are never diagnosticated, which terminate in fatal peritonitis.

I shall first describe the various forms of gonorrhœa in the order mentioned, and then their complications:

1. **Vulvitis.**—This is especially an inflammation of childhood; it is common in young women, it is rare in the aged. It may be limited to the labia majora, or it may include the nymphæ and the mucous membrane of the vestibule and introitus vaginæ. It is a typical inflammation, for it includes heat, pain, swelling, and redness of the affected parts. If the mucous membrane becomes involved, there is a discharge of dirty, yellowish, or greenish pus, acrid and excoriating. Intertrigo becomes annoying; walking is difficult and painful. The disease is prone to extend to the vagina, and not infrequently to the urethra, especially in young

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* I have seen cases in which the patient was conscious of the beginning of the disease —pain, or soreness, or swelling being present—within a few hours from coitus. I have recently seen a case of gonorrhœa of the rectum and anus, with extensive ulceration of the mucous membrane and contiguous skin, in a young woman about eighteen years of age, in which coitus *per anum* at night was followed by evidences of gonorrhœa in the morning. Of course, a portion of the symptoms was due to injury to the sphincter muscle and the anal mucous membrane, but the distinctive evidences of gonorrhœa quickly appeared in addition to the effects of trauma.

children with whom the meatus urethræ is prominent. In those who have not reached puberty the underlying cellular tissue is seldom invaded.*

In those who have passed puberty the cellular tissue is frequently invaded, the skin becoming hard and dense, or œdematous and boggy. In the former case the condition is frequently suggestive of elephantiasis, the enlargement of the labia being sometimes very great; but the termination in all cases which I have seen has been resolution *ad integrum*, after a period of three or four weeks. In the other cases we have true phlegmonous inflammation, with the formation of abscess which is sometimes quite extensive, the pus burrowing into the cellular tissue of the pelvis. In the majority of cases which I have seen, however, the swelling is in the direction of the least resistance—that is, toward the other *labium majus*—the position being very favorable for its surgical treatment. Why the infectious medium should in one case cause a phlegmonous and in another a nonphlegmonous inflammation is not always apparent. Probably traumatic influences occasionally favor the former result, the tissues being bruised or contused by violence of some sort, and the infectious element entering through the broken skin or mucous membrane.

**Differential Diagnosis.**—The diagnosis of gonorrhœal vulvitis is sometimes easy and sometimes difficult. It is especially apt to be difficult in children, by whom it may be acquired from the parents, from contact with other children, boys or girls who are contaminated, and from criminal violence. The greatest caution and judicial impartiality of mind are necessary in making a diagnosis when rape has been alleged; for not only the liberty but in some States the life of the accused person depends upon the determination of the crime. In view of all the recent bacteriological developments in this field, a diagnosis of gonorrhœa should not rest mainly upon the presence or absence of the gonococcus. Vulvitis or vulvo-vaginitis in children is said to result from the migration of worms from the rectum to the vulva or vagina, but, considering the closed condition of the vagina in most children, I should be skeptical concerning such a cause unless the evidence were very conclusive. Differentiation from vulvitis associated with epidemic diseases in children must undoubtedly be made, especially the eruptive fevers. Contributions to this subject have been made by Von Dusch (Deutsche medicinische Wochenschrift, October 11, 1888), Ollivier (La semaine médicale, October 24, 1888), Suchard (Revue mensuelle des maladies de l'enfance, 1888, p. 265), Tait (Lectures on Gynæcology, 1888), and the writer of this article (Medical News, July 6, 1889). In addition to the differentiation from the catarrhal form of vulvitis to which the foregoing remarks apply, one must be prepared to exclude the phlegmonous form, which, if it occurs in children, is more usually of traumatic than of infectious origin, and the diphtheritic which is not infrequent in epidemics in which diphtheritic inflammations are present. The differential diagnosis of vulvitis in those who have passed the age of puberty is not usually difficult. Enlargements and inflammations of the vulva from traumatism, puerperal accidents, and elephantiasis are easily excluded ; syphilis in this location must be studied in connection with its other phenomena in the secondary stage, though the primary sore may sometimes be discovered in connection with the enlargement of the labia and inguinal glands. Cancer affecting the vulva is so pronounced in its symptoms, especially pain, corrosion, and swelling, that its exclusion can almost invariably be made without difficulty. The subject of complications and treatment will be discussed in a subsequent portion of this paper.

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* I can recall but one case, a child about ten years of age, seen in consultation in whom the inflammation in the right labium majus had terminated in an extensive ischiorectal abscess opening near the lower portion of the labium.

2. **Bartholinitis.**—Inflammation of the vulvo-vaginal glands, or glands of Bartholin or Duverney, is a not uncommon form of gonorrhœa. I have never seen it except in adults. It is sometimes found unassociated with other forms of the disease ; indeed, cases are recorded in which a single gland or even a single duct has been the seat of the disease, and for a prolonged period. I am disinclined to believe that the disease ever limits itself to so small an area. It is quite possible, however, that this portion of it might remain after others were cured. The symptoms are those of an abscess in any other tissue which is easily distensible. The abscess may be no larger than a chestnut, or it may be as large as a small egg. It may exist in connection with a vulvitis, and may be included in a phlegmonous inflammation of the *labia majora.* Destruction of the gland accompanies the disease. Differentiation must be made from simple catarrhal inflammation of the gland, from retention of glandular secretion, and from traumatic inflammation.

3. **Vaginitis.**—So far as symptoms are concerned, it is this form of gonorrhœa which has most frequently brought women to me for relief. The urethritis from which women suffer is not comparable, as to pain, with the urethritis of men, and the endometritis of gonorrhœa has few acute symptoms, in some cases not any. In those forms of the disease in which the peritonæum is involved the pain is so severe that individuals are not usually to be treated as out-patients. As has already been stated, I dissent entirely with those who say that gonorrhœal vaginitis is a rare condition, at least according to my experience. In children it is usually, perhaps always, associated with vulvitis. In young adults it is the most common form of the disease ; in the mature and aged it is comparatively rare. No one denies the possibility of development of the gonococcus upon the vaginal pavement epithelium in children : why should it not de-

velop upon the same tissue in adults? It would be absurd to hold that it is always secondary to infection of the uterus in children; it is almost as absurd to maintain the same universal proposition in regard to adults. In young adults the os uteri is frequently almost impervious, and the vaginal portion of the cervix small and retracted. The urethra in such women is also less exposed to infectious media than the vagina, and the latter is more adapted to retaining fluids which may have been injected into it than the vagina in women who have been long married or have borne children. But whatever the theory may be, the fact with me is unquestionable that vaginitis is the commonest form of the disease in my experience, and probably for the reason that has been given, that children and young women include the greater number of sufferers with gonorrhœa. The symptoms are unmistakable in the great majority of cases, and in the present state of uncertainty concerning the specific influence of the gonococcus (see note, page 1046, concerning investigations of Bumm, Bockhart, and others), as the sole cause of the disease, and the liability to mistake the true gonococcus with one of the five varieties of the pseudo-organisms with which Bockhart says it is morphologically identical. I think we may eliminate the question of its presence, in the greater number of cases at least, and make our diagnosis on the basis of the clinical phenomena alone. It is only necessary to quote such names as Nöggerath, Sänger, and Welander in support of the statement that clinical facts are sufficient to determine a diagnosis. I have in a number of cases seen this form of the disease in young unmarried women whose habits and character have been irreproachable save for the lapse or two which was the cause of their misery. The symptoms in such cases have been very pronounced, and perhaps they will best serve as types of gonorrhœal vaginitis. Fear of discovery of their fault, retention of secretions within the vagina, and active condition of the vaginal epithelium, are all favorable conditions in such cases to the exuberant development of the disease. The period of incubation is short; it may not be more than twenty-four or forty-eight hours before pain is felt in the vagina, walking becomes difficult, the tissues are swollen and hot, and the color of the mucous membrane is a dark, dirty red, which I have compared to the color of *wet hemlock sole-leather.* The stage of congestion is followed by the stage of secretion, the secretion being purulent, the pus sometimes yellow and sometimes green. An examination even with a small speculum at such a time is exquisitely painful, and the slightest rudeness tears away the epithelium of the vagina or the vaginal portion of the cervix, leaving a bleeding surface. This acute stage may last one week, two weeks, three weeks, possibly longer if it is untreated, and almost always longer in young children, but I have never seen a case in which it was followed by cicatrization; so that the statement of Bumm and others that gonorrhœa is essentially a superficial disease is probably true, at least in so far as it applies to the vagina.

**Differential Diagnosis.**—The admission of sexual intercourse on the part of the patient, and the quick succession of the phenomena mentioned, make a diagnosis easy. Those conditions with which gonorrhœal vaginitis may be confused are usually to be eliminated without difficulty. They may be considered as catarrhal, diphtheritic, and phlegmonous vaginitis, also endometritis with profuse discharge. Catarrhal vaginitis may be an accompaniment of the eruptive fevers, constipation, rectal disease, and anæmia, but in none of these cases would gonorrhœa be suspected. In the pregnant or puerperal state a profuse vaginal discharge is not unusual, and it is quite necessary to be on the lookout for other symptoms of gonorrhœa, which not infrequently coexists with pregnancy, both in its acute and chronic or recurrent forms. The leucorrhœa which so often comes before and after menstruation must also be eyed with suspicion in suspected cases, and its relationship to infection carefully inquired about. The same remark will apply to the catarrhal vaginitis which is so common with women of uncleanly habits.

Diphtheritic vaginitis may be easily excluded, while the phlegmonous form is rare and should give a history of violence of some kind. Such a condition (phlegmonous vaginitis) might follow a severe labor, violent coitus, a blow or thrust; and in some cases gonorrhœa may coexist, and the diagnosis be obscured by the severity of other conditions. With reference to the misleading influence of acute endometritis, a careful examination will, of course, readily show that the symptoms do not proceed from vaginitis. That this form of gonorrhœa may long remain latent, is shown by the countless cases of gonorrhœa in men which are contracted from women who suffer with no acute symptoms, and in whom an examination reveals nothing conclusive of gonorrhœa. I have seen this fact demonstrated repeatedly.

**Senile Vaginitis.**—It would seem almost supererogatory to make a separate distinction for vaginitis under this nomenclature. This distinction has frequently been made, however, and with reasons which seem sufficient, for the conditions which are present in vaginitis in women who have passed the menopause differ from those which obtain in younger women. The tissues of the vagina and vulva are in a state of atrophy, the abundant fat of earlier years has been absorbed, the hyperæmia of pregnancy and menstruation no longer occurs, and the functional activity of glands and follicles is less marked. At this period of life a woman is less susceptible to the virulent action of gonorrhœa than in early life, and the influence of the disease, when contracted, is less intense and extensive. Vaginitis does occur, both gonorrhœal and nongonorrhœal, in the aged; and the former, in its latent form, may be carried over from the period of præ-menopause to that of post-menopause. It is characterized by an abundant muco-purulent discharge, the secretion being watery, of a dirty-yellow color; and though the epithelium is easily bruised, there is little or no swelling of the tissues, and the bleeding which follows bruising is not as free as in younger women. The mucous membrane has a dirty brown appearance, and under the mucous membrane of the vestibule one frequently sees slight effusions of blood. The discharge is irritating, excoriates the thighs and buttocks, and the consequent scratching and rubbing result in infiltration and parchmentlike hardness of the skin. Condylomata and inguinal enlargements rarely, if ever, occur. The condition is a most annoying one, is worse in cold than in warm weather, and may persist for many months, especially if the person is uncleanly in her habits. It is not easy to differentiate the gonorrhœal form from the nongonorrhœal, for the symptoms are quite similar. The history and surroundings of the patient must be of assistance in determining the diagnosis. In women who have had gonorrhœa just prior to the menopause, and whose lives are not above reproach, such a vaginitis as has been described is usually gonorrhœal. In other women, whose lives are exemplary and always have been, the vaginitis may be a concomitant of an irritated or torpid rectum; it may be associated with malignant disease, or it may be one of the expressions of anæmia.

4. **Urethritis.**—Gonorrhœal urethritis in women is not usually the serious disease that it is in men. It has its serious consequences, to be sure; it is very frequently accompanied or followed by cystitis; but the serious lesions of the ureters and kidneys, the destructive strictures of the urethra, and the disorganizing lesions of the bladder, which are matters of every-day occurrence as sequels of gonorrhœa in men, are rare indeed in women. Not that these may not occur in women; they may and do occasionally, but the topographical anatomy of the female renders them comparatively amenable to treatment. Gonorrhœa in the female has its serious consequences, but they occur rather when the disease progresses through the uterus and thence to the peritonæum, than when it follows the urinary channel. The greater frequency of urethritis compared with other forms of gonorrhœa, in the opinion of certain able writers, has been referred to. I have not found it thus frequent. Forty per cent would be a liberal estimate for those who have suffered with urethritis in my experience. It has not seemed to me a cause of great disturbance in children, though the situation of the urinary meatus in children is an exposed one. In married and mature women it is relatively frequent, in the aged it is rare. Its period of incubation is shorter than with men, and about the same as in vaginitis. Its invariable symptoms are burning and smarting in the urethra, frequent and painful micturition, and more or less swelling and sensitiveness of the urethral mucous membrane. The

epithelium of the latter becomes eroded with the slightest touch, bleeding freely. Pus exudes from the meatus after the congestive stage has passed, but I have never yet seen such intense inflammation and suppuration as commonly attend urethritis in the male. Were this the sum and substance of gonorrhœa in the female, it might usually be considered a trivial and easily cured disease. The glands and follicles by which the meatus and a portion of the lumen of the urethra are surrounded, furnish opportunity for ramification of the urethral disease, and may complicate it in a very troublesome manner, causing indefinite delay in the cure, unless the follicles are carefully investigated, one by one, and thoroughly treated. Eraud has described three varieties of gonorrhœal urethritis, based upon their differing histological characteristics. His paper may be consulted for this differentiation (Congres internationale de dermatologie et de syphiligraphie, 1890, p. 642).

Sänger also describes a periurethritis, an interstitial urethritis, and a stricture of gonorrhœal origin, and states further that they are occasionally followed by suppurative catarrh of the bladder, ureters, and pelvis of the kidneys. The study of urethritis with the endoscope has not found as many workers as has endoscopy of the male urethra.

Janowski recommends for this purpose (Wien. med. Presse, 1890, xxxi, 1409) the straight endoscope of Grünfeld, the pan-electroscope of Leiter, the Nitze-Leiter instrument, or that of Skene. By means of the endoscope Janowski has demonstrated chronic papillary urethritis, and Janowski gives as varieties of gonorrhœal urethritis, from the same means of investigation, *U. simplex chronica* and *U. granulosa.* His paper (*loc. cit.*) may be consulted for an elaboration of the foregoing. The duration of urethritis is not usually so great as that of vaginitis. Plenty of cases are relieved of the troublesome symptoms in the urethra and bladder after two weeks of treatment.

5. **Endometritis.**—A gonorrhœal endometritis is likely to be a far more serious matter with a woman than a urethritis. In addition to the acute and chronic or recurrent varieties, we may distinguish an endometritis of the cervix, of the cervix plus the corpus, and of the cervix plus the corpus plus salpingitis, the gravity of the disease increasing with its extension. The extension is from cell to cell, but that does not imply that the entire endometrium becomes infected as the disease progresses. It may be involved in strips or islands, continuity being preserved, of course, at one or more points in order that progression from one cavity to another may be possible.*

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* Bumm believes that extension may also be accomplished from cervix to corpus by the regurgitation of menstrual blood, but such a hypothesis should work both ways; and if a current setting back into the cavity of the corpus carried gonococci, which is very problematical, why may not the return current out of the uterus carry the offending organisms

This fact shows the necessity for the development of uterine endoscopy; for without an accurate knowledge of the areas of disease of the endometrium, which can be ascertained in some diseases at least only by sight, any method of treatment adopted, whether by applications to the endometrium or the use of the curette or other instruments, is crude and inexact, for it must include the entire mucous membrane, diseased and healthy alike. Steinschneider believes that all forms of gonorrhœal disease in women are secondary to metritis. Bumm believes all cases of gonorrhœal vaginitis are secondary to metritis. I am satisfied that there is a primary and a secondary endometritis, the former being the more common in married and parous women, the latter in the young and nulliparous.*

The symptoms with endometritis, if it exists alone, are usually few and unimportant. A dirty, muco-purulent, viscid discharge, and the fact that those who cohabit with her suffer with gonorrhœa, may be the only intimation a woman has that she is diseased. Such a history is repeatedly given by prostitutes. In a few cases the endometrial inflammation is intense, the vaginal portion of the cervix is swollen and very tender. In such cases gonorrhœa is certainly not a superficial inflammation, and these are probably instances of mixed infection. Erosion of the os uteri is also a very common symptom with endometritis. It occurs alike in the parous and the nulliparous. It is due partly to the bathing of the epithelium of the os in the discharge from the endometrium and partly to friction upon the floor of the vagina. It is not exclusively a symptom of gonorrhœa, for it accompanies abundant endometrial discharges which are not gonorrhœal in character. The os internum frequently serves as a barrier to the extension of the disease. The fact that in the young and nulliparous it is almost a sealed portal, and that infection does progress beyond it, is an argument in favor of the extension of the disease by the epithelium. If the disease advances to the corpus and pregnancy ensues, an abortion may result. This matter will be referred to again. Having reached the corpus, the disease may be arrested for some time, perhaps being intensified at the cornua before it advances to the tubes.† The ex-

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away? He also thinks gonococci may be introduced into the uterus mechanically during coitus or intra-uterine instrumentation or medication.

* I have seen direct infection of the cervical endometrium in a hospital patient upon whom trachelorrhaphy had been performed. After the sutures were removed she was allowed to go home and spend Sunday. When she returned the cervical wound was gaping, intensely inflamed, and secreting pus abundantly. Her husband admitted that he had gonorrhœa.

† I recently saw such a case in a young prostitute. The uterine canal was extremely narrow, and in each cornu was an abscess about as large as a walnut, discharging constantly through the os uteri. In tying off the tubes the tissue broke down like wet paper. The tubes were congested, but scarcely pervious. The patient had suffered several weeks with the usual symptoms of acute peritonitis.

tension of the disease to the tubes is a matter of common occurrence—in fact, the majority of women who suffer with disease of the uterine appendages probably suffer with gonorrhœa as a cause of it. The progress of this disease from one stage to another may be slow or rapid. In young newly married women the severe symptoms may culminate within a month, as was first shown by Nöggerath in his classical paper. Then a long period of invalidism may follow, with sterility and various other severe complications. The anatomical conditions of the endometrium are such that, if it has become infected, it is almost impossible to restore it to a healthy condition by any measure short of a severe surgical operation.*

It is often very difficult to prove the existence of gonorrhœal endometritis, especially in its latent condition. The presence of a purulent discharge from the uterus, development of gonorrhœa in those who come in contact with such a discharge, the latter individuals being free from the disease before such contact, promiscuous intercourse, or intercourse with one whose habits in regard to the sexual relation have been bad, are all suggestive factors in determining a diagnosis. The diagnosis is strengthened by the presence of gonococci in the discharge. Differentiation must be made from a simple endometritis with mucous or muco-purulent discharge; from malignant disease of the endometrium with profuse discharge, the corroding character of which soon becomes evident; and from endometritis due to benign tumors of the endometrium or the muscular tissue of the uterus.

6. **Salpingitis.**—It is hardly possible to conceive of gonorrhœal salpingitis as a primary disease. The same cause which produces it must previously have been at work upon the endometrial mucous membrane. (Saxinger is quoted by Sänger (*loc. cit.*, p. 200) as reporting gonorrhœal salpingitis in virgins. This seems extraordinary, if true. Sänger explains it by the possibility of contracting gonorrhœa in other ways than by impure coitus.) This is eminently the disease of young adult life, and its destructive effects not only in sterilizing women by occlusion of the abdominal ends of the tubes, but in leading to lifelong misery and often death, make it one of the most important surgical diseases to which professional attention has ever been directed. Though it belongs to adult life, it is not unknown in childhood. Sänger has quoted a case of Welander's in which general peritonitis of gonorrhœal character (preceded, of course, by salpingitis) occurred in a child five years of age. Mercier observed as early as 1846, in autopsies upon prostitutes, that salpingitis and ovaritis were very common among them. The epoch-making labors of Bernutz and Goupil in connection with pelvic peri-

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* While the gonococcus is often found in the secretions of the cervical endometrium, it is rarely found in those of the corporeal endometrium.

tonitis threw much light upon salpingitis, and incidentally upon the gonorrhœal variety. (Terillon (*loc. cit.*) quotes Bernutz and Goupil as reporting twenty-eight cases of pelvic peritonitis or salpingitis among ninety-nine cases of gonorrhœa.) Nöggerath clearly saw the destructive character of the disease, its especial relation to the child-bearing function, and its great frequency among newly married women whose husbands had at some time in their lives suffered with gonorrhœa. Tait, Sänger, and others have made important contributions to the knowledge of the subject, especially with reference to its destructive character, and the frequent necessity for its treatment by severe surgical measures. As already intimated, its course may be a rapid or a slow one. The entire mucous membrane of the tube may be found diseased, or only portions of it, and diseased parts may be encysted or walled off from parts which are less diseased or uninvolved. We may have tubal abscess or interstitial salpingitis. Terillon thinks the disease usually affects both tubes, and he accounts for the almost universal prevalence of sterility among prostitutes by the prevalence of salpingitis among them. (This can not be taken as a rule that is by any means universal, for there are countless cases in which prostitutes marry and have families, though they may have been sterile during the years in which they practiced prostitution.) Whatever the *rôle* of the gonococcus may be as an exciter of inflammation in other forms of gonorrhœa is probably exercised also in salpingitis. It is found not only in and on the pus-cells in suppurative salpingitis, but in and on the cylindrical epithelium of the mucous membrane of the tube (Bumm). Bumm's opinion that the gonococcus does not penetrate the deeper layers of tissue of the tube is opposed by Wertheim (Wiener klinische Wochenschrift, 1890, iii, 476), who found it in five cases of pyosalpinx in the pus of the tube, and in three of them in the epithelium and the connective tissue. Other observers who have found the gonococcus in connection with pyosalpinx are Westermark, Kelly, Martin, and Orthmann. To write the history and pathology of gonorrhœal salpingitis would be to cover the subject of salpingitis in general, and that, of course, would be more appropriate for a work on general pathology. This excuse may account for any apparent deficiency of detail in a subject which is so important as this. As in salpingitis from other causes, the gonorrhœal variety may be catarrhal or interstitial. In the former the tube may be only slightly enlarged, especially if the pus has free exit through the uterus. If there is obstruction to its exit, the tube may gradually become greatly distended, and its contents may be confined to one or several sacs. With catarrhal salpingitis of any severity we are almost certain to have pelvic peritonitis; and if the communication between the tube and ovary persists for any length of time after the establishment of the disease, the abdominal end of the tube remaining pervious, we will be almost certain to have ovaritis also. The disease is marked by frequent recurrences and exacerbations under the influence of exposure to cold, excesses of various kinds, the puerperal state, etc. Rupture of a pyosalpinx with fatal results is probably not uncommon. In the interstitial variety the development of the disease is gradual, there is great hypertrophy of tissue, and, while peritonitis is a common accompaniment, ovaritis is less common than with the catarrhal variety. Both of these forms of disease are attended with great pain and great danger to life, and, as a rule, the function of the organs is entirely destroyed. The surgical procedure by which these diseased organs are removed, in spite of its abuses, is a boon to humanity which can not be overestimated.

**Ovaritis.**—Although a gonorrhœal salpingitis may exist without a consequent ovaritis, a gonorrhœal ovaritis is impossible without an antecedent salpingitis. In the interstitial form of salpingitis, in which there is a slow and progressive hypertrophy of tubal tissue, the structure of the ovary may remain uninterfered with for a long time. Catarrhal salpingitis also may be localized, and the abdominal end of the tube occluded by an infratubal exudate which will prevent the passage of infectious material to the ovary. But if infectious material traverses the bridge which unites tube and ovary, or if peritonitis is excited in connection with an existing salpingitis, the inflammatory process will, as a rule, extend to the ovary also. The ovary may be simply dislocated and imbedded in a mass of exudate, more or less extensive and more or less dense, its nutrition and function being interfered with. In cases of slight intensity the tunica albuginea will bear the greater portion of the inflammatory process. If the process is severe and very virulent, abscess of the ovary will result, and the organ will usually be entirely disorganized. Like some forms of pyosalpinx, it may be so walled in by exudate that it is effectually shut off from the pelvic viscera, or, like others, its walls may be friable, and the possibility of rupture be a constant menace to the patient's life. The attachments which these inflamed and diseased tubes and ovaries make to the pelvic peritonæum and the pelvic and abdominal viscera, often render their removal among the most formidable and dangerous of surgical operations. The diagnosis of gonorrhœal ovaritis must be made in connection with other manifestations of the disease ; it is never primary. As to its duration, differentiation, prognosis, and treatment, the same remarks apply which are appropriate for salpingitis.

**Peritonitis.**—There are probably few cases of gonorrhœa which extend as far as the Fallopian tubes which do not excite a peritonitis. This may be of limited extent, including principally the peritonæum covering the tubes and the fundus uteri, it may extend to the peritonæum of the surrounding viscera and the pelvis, or it may become general. It may be of moderate intensity and with little or no appearance of exudate, or it may be manifested by the presence of serum, pus, and adhesions of greater or less extent and firmness. It is sometimes produced by the transmission of the infecting virus through the tubes to the peritonæum itself, and at others the infecting medium is probably carried by the lymphatics. All the phenomena which have been mentioned are perfectly familiar to every one who has had even a moderate experience with abdominal surgery. This is a disease which is particularly prone to occur before middle life. Sänger speaks of the period between the twentieth and thirtieth years, when the tissues and tissue changes are most active, as the period of greatest frequency.

Nöggerath's attention was directed to its frequency among newly married women, and I have seen it many times in young prostitutes under twenty-five years of age. One of its most marked features is its tendency to recur, especially in connection with the hyperæmia of the menstrual period. Nöggerath alludes to this fact under the term *recurrent perimetritis.* Recurrent attacks are almost certain to result in envelopment of the appendages in inflammatory exudate, both sides being usually implicated. One of the least serious of its results is the establishment of sterility, as the abdominal end of the tube becomes sealed. With it may be associated abscess of the pelvis apart from abscess of the tube or ovary, though dependent upon the extension of the disease from one or both of those organs. It is to be differentiated from traumatic noninfectious peritonitis, which may be caused by blows, by lesions accompanying a severe labor, or by rough manipulation of the genital organs, and from infectious peritonitis which is nongonorrhœal in character, such as the peritonitis of puerperal septicæmia, of the infectious fevers, or of severe disease of the rectum.*

## COMPLICATIONS.

**Condylomata.**—Among the most common of the complications of this disease are the growths upon the skin of the external genitals which are known as condylomata. These are due to the infectious character of the secretions which are poured out from the gonorrhœa-invaded tissues. They are highly infectious, and the abraded surface of one of them when brought in contact with the contiguous uninjured skin (as in the opposing folds of the nates or labia) will cause a similar development. They are apt to be especially abundant around the fourchette of the vulva and the anus. They may be flat or acuminated, a loose accumulation of epidermal scales, highly vascular, or nodes slightly raised from the surrounding surface. They may be dry, or abraded and secreting, the secretion being viscid and infectious. They may be isolated, or in groups or masses an inch or more in length. Isolated formations are prone to coalesce and conglomerate. They do not appear until the secreting stage of the gonorrhœa has been reached, and remain several weeks. They finally disappear without a scar. They are insensitive to the touch unless excoriated, and are most likely to occur with women of unclean habits. (The skin of some women seems to be insusceptible to this form of growth, or perhaps, in cases in which they are absent, the necessary virulence of the particular element which causes condylomata is wanting. Instead of condylomata, the discharge of gonorrhœa upon surfaces which are in apposition sometimes produces intertrigo, the epidermis being rubbed off and the parts becoming sore and painful, especially when the patient walks.)

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* Bumm says that peritonitis associated with gonorrhœa is always due to mixed infection, the streptococcus and not the gonococcus being the efficient agent.

**Enlarged Inguinal Glands.**—This complication is not uncommon with gonorrhœa, and very often results in abscess. Sänger thinks it always results from a mixed infection.

**Gonorrhœa of Nose and Mouth.**—These complications are possible, for the disease may occur on any mucous membrane. It is referred to by Sänger, but he quotes no case. I have never seen it in these locations.

**Gonorrhœa of Anus and Rectum.**—This form of the disease is not uncommon in women, and is the source of much pain and annoyance. In my experience it yields readily to treatment. Horand (*loc. cit.*) saw thirteen cases of this form of the disease among four hundred and eighty-three cases of gonorrhœa in women.

**Gonorrhœal Arthritis.**—I have never seen but one case in women in which the gonorrhœa and the arthritis seemed definitely related. The intimacy of the two conditions has always seemed to me rather questionable. Jullien reports the discovery of gonococci in the blood, and if this is true they might be transmitted to the joints; or they might be carried in the lymph circulation, on the supposition that they are the sole cause of the disease. Welander says there may be a gonorrhœal arthritis from mixed infection. He doubts the presence of gonococci in the blood, and has not seen scientific evidence of their presence in the joints in a single case. This subject is discussed at greater length elsewhere.

**Cystitis.**—This complication is a very common one, but neither so severe nor so persistent as with gonorrhœa in men. It is quite amenable to treatment, and cases are rare in which it extends to the ureters and kidneys.

**Syphilis and Chancroid.**—These diseases may be associated with gonorrhœa, the symptoms of each disease being distinct and easily recognized.

**Gonorrhœal Ophthalmia.**—This very important division of the subject is discussed elsewhere.

**Relation of Gonorrhœa to Sterility.**—Reciprocal influence of gonorrhœa with menstruation, the pregnant and puerperal states. Gonorrhœa being an inflammatory condition, it would naturally follow that if an acute attack were added to the hyperæmia of the menstrual epoch the result would be an unusual loss of blood, and possibly undue frequency of the menses. If the pelvis were the seat of new growths which implied an additional vascularity, the hæmorrhage might be sufficiently profuse to require active measures for checking it. Excessive menstruation or polymenorrhœa is therefore one of the symptoms which may be expected in connection with acute gonorrhœa. This statement has been verified by the observations of Welander and Sänger (*loc. cit.*). That gonorrhœa may be transmitted through the medium of the menstrual blood is extremely probable, the infectious elements being latent within the folds of the uterine or vaginal mucous membrane and carried out during coitus. The hyperæmic condition of the pregnant state, and the abundance of glandular secretion during that period, are also favorable to the reception and transmission of gonorrhœa. With young women who are thus infected the disease is often very severe, especially in the forms of vaginitis and endometritis. An exuberant crop of condylomata is also a very common phenomenon in such cases. That interruption of the pregnant state may be caused by gonorrhœa is a very reasonable supposition, and is vouched for by high authority. Nöggerath reports twelve cases of abortion in fifty-three cases of gonorrhœa in pregnant women (Archiv für Gynäkologie, 1888, xxxii, p. 322). Kroner (Archiv für Gynäkologie, xxxi, ii, p. 261) reports thirty-one cases of gonorrhœa in pregnant women, of which twenty-three went to term, five aborted, and in three premature labor occurred. Sänger thinks that both abortion and placenta prævia may be due to gonorrhœa, though why the last-mentioned accident should be a result I do not know. The influence of gonorrhœa during parturition and the puerperal state is a matter of great importance. The hosts of infants who lost their eyesight in years gone by, before this disease was properly appreciated, from an infected parturient tract, are witnesses of the truth of this statement. The lochial fluid, like the menstrual blood, may be the medium for the transmission of the disease, and conversely the puerperal state renders a woman very sensitive to the acquisition of the disease. A pre-existing gonorrhœa may become very active and intense during the puerperal period. Many of the severe and fatal cases of puerperal septicæmia are of gonorrhœal origin; while Sänger is authority for the statement that before Credé's method of treating gonorrhœal ophthalmia in the newborn was introduced at the Leipsic maternity twenty-six per cent of the infants born there were sufferers from that disease. All the forms of gonorrhœa may be acquired during the puerperal state, or may be relighted into activity; and they may be independent of septic puerperal condition of other origin, or they may be associated with it.

The relation of gonorrhœa to sterility has been touched upon from time to time in this paper. It was one of the important features in Nöggerath's original article, and one which excited astonishment and unfavorable comment. Nöggerath's prediction, that time would prove the truth of his statements concerning the destructive influence of this disease upon the reproductive power, has been measurably verified. Sterility is the result of gonorrhœa, not in all cases, but in those in which the disease extends to the Fallopian tubes, excites intense inflammatory action in them, and seals their abdominal ends. Sterility in such cases is irremediable. Even if the function of the ovaries remained (and in most cases the same inflammation which has destroyed the functional power of the tube has destroyed that of the ovary also), the only avenue of approach for the ovum to the uterus is cut off; the spermatozoön is entirely out of reach. The efficient cause of sterility subsists, therefore, in the tube, and the tube being disorganized, conception becomes an impossibility. A more or less complete cure of the inflammatory condition is possible, but a restoration of the tube *ad integrum* is impossible.

**Treatment.**—The subject of treatment for gonorrhœa in women is a large one, for it embraces not only the management of the disease and its complications, but the consideration of precautionary measures in men who consort with infected women, and the adoption of preventive treatment in women. Gonorrhœa will probably exist as long as men and women are the slaves of sexual appetite. Far be it from me to defend the gratification of that appetite in any but the normal and proper way—that is, in the lawful relationship of husband and wife. The idea of licensing a vice by any system or plan yet devised—an expedient which has always proved a failure—ought to be abhorrent to good morals and good citizenship. But, whether we regard the moral side of the subject or not, we must consider the sanitary side, and accept the fact of susceptibility to gonorrhœa and its actual and widely spread existence. I shall not offer any theory as to the proper way to treat prostitution. I have discussed that question elsewhere (see author's paper on The Unrestricted Evil of Prostitution), and have seen no reason to change my views. With reference to prophylaxis, scrupulous cleanliness of the genital organs before and after coitus would prevent many cases of gonorrhœa. It is simply the application of the surgical gospel of asepsis, for gonorrhœal virus could not successfully compete against the scrubbings and washings with which a careful surgeon prefaces his operations. But there are few who would be willing to use the brush, soap, and water with thoroughness before and after coitus. As a measure of comparative safety, an abundant vaginal irrigation with hot water or solution of carbolic acid, 1 to 40, or solution of creoline, 1 to 50, may be recommended. Sänger recommends that men instill into the urethra a few drops of a two-per-cent solution of nitrate of silver previous to coitus, and that prostitutes irrigate the genitals with a 1-to-20 solution of sublimate. The latter seems to me dangerous advice, and, in regard to prophylaxis in general, we must not forget that with very many individuals the gratification of the sexual appetite is a matter about which they are prone to reason and propose safeguards at any time rather than the time when they are to be put in practice. Equally important with prophylaxis in this matter is *quarantine.* All women suffering with gonorrhœa (and other venereal disease), who can not or will not be treated at their homes, should be placed under observation and treatment in hospitals. The great prevalence of the venereal diseases is largely due to the fact that many of those who suffer with them, both men and women, continue to indulge in sexual intercourse even when conscious that they are diseased, thus multiplying the disease indefinitely. It would be difficult in the present state of society to constitute the infecting of one person by another as a legal offense or misdemeanor, but it ought not to be difficult to secure the passage of a law compelling any one with this disease to have either public or private medical attention, as we compel those who have cholera, smallpox, and other infectious diseases which are very dangerous to the community. Another important question in this connection is, How long is the disease infectious? Certainly as long as any of its symptoms remain; when once a woman has been infected, her capacity for infecting others may remain indefinitely.

The treatment of gonorrhœa will vary according as the disease is in the acute or chronic stage. Above all things cleanliness is a prerequisite. The external genitals should be frequently sponged off with absorbent cotton moistened with a hot solution of sublimate or carbolic, salicylic, or boric acid of moderate concentration, the cotton being burned or otherwise effectively disposed of after use. Irrigation of the vagina with the same solution should also be practiced two or three times daily under the direction of a physician or a competent nurse; and a vulvar pad of absorbent cotton snugly secured by a T-bandage should be constantly worn as long as any discharge from the diseased parts continues. If the urethra or bladder is involved, alkalies and balsams may be used. In the beginning of the acute stage, when the vulva, vagina, urethra, or cervix uteri is engorged and very sensitive, it will usually be found inadvisable to make local applications on account of the intense pain caused by manipulation. When the engorgement and sensitiveness have in a measure subsided, a direct attack may be made upon the affected parts. The position which the patient assumes for treatment is immaterial, although it must be such as to enable one to remove all secretions with thoroughness. If the bladder and urethra are involved, irrigation should be practiced daily with warm boric-acid solution in moderate concentration. The balsams may be administered by the mouth, or, since they are eliminated by the kidneys, they may be applied in the form of bougies to the urethra and bladder. Severe manipulation of the urethra will not only cause intense pain, but will tend to increase the inflammatory condition and encourage the formation of stricture. If condylomata are present, the external genitals should be frequently washed with a two or three per cent solution of creoline, the hair upon the pubes should be removed, and applications may be made of nitrate-of-silver solution, 1 to 8, fuming nitric acid, nitrate-of-mercury ointment, or the thermocautery. The latter method is excellent, especially if the growths are exuberant and pediculated. Of course, the operation requires an anæsthetic. Cysts and abscesses of the genitals are to be treated with the same deference to surgical principles that are observable elsewhere. In addition to the irrigation the vagina should be gently but thoroughly swabbed daily with a 1-to-8 solution of nitrate of silver and then tamponned with cotton soaked in a mixture of subnitrate of bismuth and glycerite of tannin, 1 to 8. The cervical canal should be kept clean by frequent curettings with the dull curette, severity in scraping being avoided, after which the strong solution (1 to 8) of nitrate of silver, or a strong solution (thirty to forty per cent) of chloride of zinc, should be applied. Prochownick has recommended the use of the constant galvanic current for the treatment of acute gonorrhœa, and is satisfied with the results which he has obtained (Münchener medicinische Wochenschrift, 1890, vol. xxxvii, p. 467). If the disease invades the Fallopian tubes, the ovaries, and the peritonæum, there will usually be but one way of curing it, and that is by means of an abdominal section and the removal of the diseased appendages. If the disease goes no farther than the tubes, the abdominal ends of the latter becoming sealed, dilatation of the uterus and drainage with the gauze tampon may in some cases effect a cure, or at any rate a remission; but the persistency of gonorrhacel elements is such that it would be assuming a great deal to say that a woman was cured of her pyosalpinx merely because it was efficiently drained. Even though the disease of the tubes were cured, their functional power would be destroyed. A woman who has once had gonorrhœal salpingitis is in a condition of insecurity as long as the diseased organs are in her body. The condition is quite analogous with that of appendicitis, in which recurrences are almost as sure to come as in any inflammatory condition of which we have any knowledge.

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